

20
YEARS
1872-1992

ELECTRONICS SPECIAL: TECH TV

A Times Mirror Magazine

Popular Science



**4X4s: GOING
HEAD-TO-HEAD**

SUPERCONDUCTIVITY GOES TO SEA



NOVEMBER 1992
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We make close comfortable.

NOVEMBER 1992

Founded in 1872/Vol. 241, No. 5

COVER STORY

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Superconductivity goes to sea

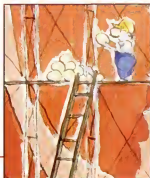
This summer witnessed the long-awaited maiden voyage of the *Yamato 1*, a prototype ship with a magnetohydrodynamic (MHD) propulsion system. It is the first of a new class of oceangoing ships and submarines that will be characterized by speed—100 knots, or 115 mph—and stealth—since its superconducting thrusters are silent.



104

High-tech harvest

Fifty percent of the world's food crops are now lost to spoilage. Scientists in biotechnology companies and universities are now working to genetically engineer vegetables, fruits, and grains that not only stay fresh longer, but are "designed" to resist pests, viruses, and blights.



91

Special section: Tech TV

Television is virtually being reinvented. We tell you how signals will be engineered to eliminate ghosts; what digital technology will do to make home-viewing more like the movies; and why interactive technologies will make TV-watching a stimulating and sociable enterprise.



4x4s: When the going gets tough

On a snowy track in Racine, Mich., near the Canadian border, POPULAR SCIENCE put five sport-utility vehicles through their paces. The GMC Jimmy, Jeep Grand Cherokee, Chevrolet Suburban, Mitsubishi Montero, and Isuzu Trooper are tested on their own terms—reliability, toughness, and convenience.

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COVER ILLUSTRATION
BY DANILO DUCAC

From The Editor

Those ripe red beauties in the clutches of Associate Editor Robert Langreth are ordinary garden-variety Jersey beefsteaks. You still can't buy the genetically altered produce that Langreth reports on in this issue, though; Langreth couldn't even convince any of the scientists to cut through the red tape and ship him one for a taste test. Nevertheless, the Food and Drug Administration plans to expedite the arrival of bioengineered foods on supermarket shelves as early as next year—with no special labeling required. So it won't be long before you can sample high-tech fruits and vegetables engineered for a variety of benefits.

Imagine produce that tastes better, resists pests and disease, and doesn't rot on the vine or during shipping. That promises to be only the beginning. The high art of genetic engineering could eventually unlock new agri-

issue. Want to know where the major candidates stand on the Endangered Species Act, the Clean Water Act, or their strategy of environmental protection versus economic development? Check their answers in this exclusive guide before you cast your ballot.

This issue also offers a couple of other seasonal favorites that are fast becoming traditions at POPULAR SCIENCE. Our annual consumer electronics section, called Tech TV, is a three-pronged dispatch covering the latest developments in interactive systems, improved definition and wide-screen broadcasts and video, and ghost-cancellation technology. And for drivers who want the very best in winter-weather traction, we once again have gathered a crop of new sport-utility vehicles and put them through ice, snow, and highway-driving tests. Our close-up report reveals the many different flavors of four-wheel driving.

On our cover this month is artist Danilo Ducak's interpretation of the *Yamato 1*, a Japanese ship with a revolutionary new electromagnetic propulsion system. This silvery bullet-shaped vessel made only about six knots during its first sea trials in Kobe harbor, yet Far East Correspondent Dennis Normile predicts that



Langreth and the juicy subjects of his High-Tech Harvest story.

cultural sources of drugs, chemicals, and fuels.

Not everyone is sure they want scientists mucking around with their fruits and vegetables, however. But "what many consumers probably don't realize," says Langreth, "is that farmers have been tampering with plant genes almost since the beginning of agriculture."

Besides nature's bounty, fall routinely brings forth a crop of politicians vying for your election-day vote. To help you get an environmental perspective on this year's presidential election and some key congressional races, the Times Mirror Magazines Conservation Council has put together a special report for this

Yamato's maiden voyage may someday be as historically significant as the first sailing of Robert Fulton's steamboat. With further development, *Yamato's* propellerless magnetohydrodynamic (MHD) propulsion system could have commercial ships cruising at 50 knots and more. Prop-driven craft have speed limitations, but with the help of superconducting magnetic coils and advanced hull materials, MHD subs and ocean liners could be transporting passengers and cargo swiftly and silently in the next century.

Fred A. A. A.
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Our finest hour.

Readers Talk Back

Sorting out priorities

While "Crisis in Education: Why Johnny Can't Do Science and Math" [Sept.] is filled with many 20/20 observations, it manages to turn a blind eye to the biggest problem: Teachers, especially of math and science, increasingly are being pressed into coaching or supervising athletics. I saw an advertisement in a local paper placed by a high school seeking coaches for basketball, football, and track who could double as math, science, and English teachers. Johnny can't do science and math because our need to compete in the technological market is not as great as our need to compete on the football field.

P. D. Allison, Cliff, N.M.

Your article missed the main reason U.S. education is so lacking: the anti-intellectual mood in this country, which manifests itself in Dan Quayle's bashing of the "cultural elite." As a high school student, I can see that other students feel it is not cool to think. No matter how much we reform our school system, unless we encourage rational thinking, the education of America's youth will not improve. After all, you can lead a horse to water, but you can't make him drink.

David Snyder, Los Alamitos, Calif.

Where's the plan?

The crisis, as confirmed by the lack of substance from your interviewees, is that no one knows what the problem is. Money is being thrown at the situation without a rational plan. The experts don't understand how or why a student learns; you have to know this before you can be effective and efficient in instruction.

Charles R. Granger
Professor of Biology and Education
University of Missouri, St. Louis

What's the incentive?

As long as there are more qualified candidates than jobs, there is little incentive for students to learn math and science. For example, I have

earned a degree in physics and a master's in oceanography, processed scientific data on computers, programmed in four computer languages, and been certified in the NetWare computer-network system. The jobs I apply for usually have 100 applicants. I have been computer job hunting for the past three years and now have an entry-level position in an auto-body shop. At least back in the '60s, we had the moon to shoot for.

William E. Gilbert
Corvallis, Ore.

It's certainly no surprise that math and science are not popular. A rock star

makes more money in a year than an engineer would ever earn in a lifetime. Also, a rock star does not spend years and thousands of dollars working hard to complete an education. Math and science teachers have even less incentive; they are paid much less and are required to obtain more schooling.

Arthur R. Allan, Mercer Island, Wash.

Beyond our backyard

You should have looked abroad for some of the solutions to our education crisis. Our high school graduates rank poorly on an international scale, and we do not compete well technically in the world marketplace. And yet, you seem to assume that there is absolutely nothing for us to learn from our competitors and, in this case, our betters.

Ervin Curtis, San Marcos, Calif.

In almost every other country, the teacher is a symbol of respect; teachers are considered guardians of the future and receive a wage that reflects this position. At a time when we should be spending money on the teachers of America's children—America's future—many states, including Montana, are cutting or considering cuts in financing for education. Short-sighted measures such as this have long been a problem in American business and education. When will we look past our collective noses to the future?

E.C. McCrone, Bozeman, Mont.

Address letters to Readers Talk Back, POPULAR SCIENCE, 2 Park Ave., New York, N.Y. 10018. Or fax your letter to us at 212-461-8062. Letters may be edited for space and clarity. We regret that we cannot answer unpublished letters.

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If you believe an orderly CD library is the sign of an orderly mind, Pioneer® makes a full line of CD changers just for you. Pioneer invented the six-CD magazine to be as ingenious at storing CDs as it is at playing them.

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Meanwhile, the Pioneer PD-M901's



new Digital Signal Processor can recreate the pristine acoustics of a church or the intimacy of a jazz club—choose any of six different environments.

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Once you put together a combination of CDs you like, you never have to leave them behind. Because the same six-CD magazines that Pioneer changers play at home are compatible with all our car multi-play changers. In fact, all Pioneer CD changers are



compatible, including those in our contemporary component systems.

Besides, the Pioneer six-CD magazine makes a handy, protective carrying case to take six hours of music with you wherever you go.

Which means, no matter how much you have to move around in a day, or how many times the scene changes, at least you can count on one thing. The music will be great.



The Pioneer synchronized dubbing team.

There's more than one way to listen to music. And only Pioneer has multi-play changers for both CDs and cassettes.

For example, just press the CD Synchro button, and the Pioneer PD-M901 six-CD changer automatically works in concert with our CT-WM70R six-cassette changer. A remarkable feat of coordination that lets you dub six CDs onto six cassettes, parts of CDs onto parts of cassettes, or any variation in between. Whichever variation you choose, our exclusive Automatic



Digital Level Controller eliminates jumps or drops in volume for a consistent sound from CD to CD.

For more information, call 1-800-PIONEER. Because it would take a lot more than three ads to explain everything Pioneer changers can do for you.

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WHAT'S NEW

EDITED BY MARCELLE M. SOVIERO AND JUDITH ANNE YEAPLE



WATER CRUISER

Yamaha's 16-foot-long fiberglass Power Fin resembles an outrigger canoe. Pushing and pulling on the sweep oar and moving your feet as if you were pedaling a bicycle moves the prototype craft forward. The production boat will cost between \$1,000 and \$1,500. A two-person version could be available next year. Yamaha Motor Corp., 6555 Kotella Ave., Cypress CA 90630.

"GREEN" MACHINE

Powered by a 24-volt lead-acid battery, Ryobi's mulching mower can cut up to a half-acre lawn on one charge; the battery recharges in 16 hours. A unique 18-inch blade forces clippings between blades of grass down to the soil. After the lawn has been cut, the mower handle can be folded downward and the entire unit placed on end to save space. Called The Mulchinator, it should be available in early 1993 for about \$400.



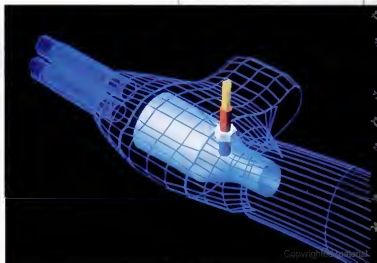
CD-ROM TO GO

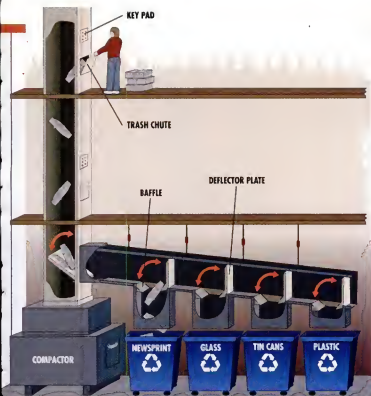
Sony's portable Multimedia CD-ROM Player includes a CD-ROM XA drive, 16-bit PC-compatible microprocessor with an MS-DOS operating system in ROM, black-and-white liquid-crystal display, and keyboard. The diminutive unit is seven inches wide, two inches high, and six inches deep and also plays audio compact discs. It should be available this fall for less than \$1,000.



EMISSIONS CONTROLLED

BMW has developed a fully controlled catalytic converter to clean up motorcycle exhaust. The device contains a compact metal-bone monolith coated with precious metals that reduce hydrocarbons, carbon monoxide, and oxides of nitrogen, while an oxygen sensor triggers fuel-air mixture adjustments. BMW's K1 100LT luxury touring bike is the first to hit American roads with a catalytic converter.





JULIE MCWILLIAMS

HIGH-RISE RECYCLING

To make recycling convenient for apartment dwellers, the NuReTec 3000 Recycling System converts trash chutes into a material-separating system. A key pad by each chute door enables residents to direct up to seven different materials to the correct bin. Nu-Recycling Technology, 31 W. Downer Place, Aurora IL 60506.

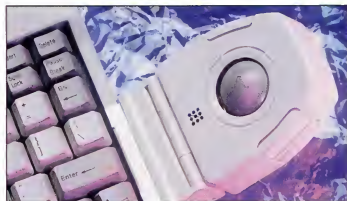


SWEET-SPOT DETECTOR

The Check Go sweet-spot finder locates the sweet-spot, or spin axis, of a golf ball. Golfers are then able to mark the spot and line up the ball on the tee so it rotates in the desired direction, reducing the chances of hooking or slicing. Price: \$25. Technasonic Electronics, 3700 W. Morse, Lincolnwood IL 60465.

TINY TRACK BALL

The Nix Microsoft-compatible track ball clips onto laptop computers and features a swiveling, two-button control to accommodate both left- and right-handed users. The \$99 Supertrak is a less expensive alternative to other similar designs. Z-Nix Co., 211 Erie St., Pomona CA 91768.



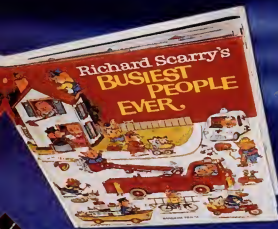
SPORT-TRACKER

Select teams from the menu or enter their code names into *The Sporting News SparTrax* hand-held data receiver and access its database for game scores, statistics, and news. Updated 24 hours a day, information is transmitted via satellite and FM sideband. Price: About \$500, plus a database fee of \$60 per month. The Sporting News Publishing Co., 1212 N. Lindbergh Blvd., St. Louis MO 63132.



OFFICE LUXURY HITS THE ROAD

The Columbus luxury MPV is nearly 20 feet long and more than seven feet wide, seating a total of six passengers in three rows; the middle-row seats swivel to create a conference area at the rear. The prototype is powered by a mid-mounted BMW five-liter V12 that develops 300 hp and has four-wheel drive and four-wheel steering. Italdesign S.r.l., Via A. Grandi 11, 10024 Moncalieri, Italy.



Now
Most Amazing



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Philips Presents The Imagination Machine

There are a lot of CD players that deliver great sound. But only one that transforms your television from something you look at and listen to into something you actually experience.

It's called the Imagination Machine.™ It comes from Philips, the inventors of CD technology. And it's the world's first CD - Interactive Player.

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As a CD audio player; the Philips Imagination Machine delivers stunning musical reproduction.

And, when the simple connection is made to your television, the door is opened to the exciting world of entertainment and education.



In the same way that compact discs capture music, the wide variety of CD-Interactive titles have captured some of the world's truly amazing experiences and put them on standard 5-inch discs called CD-I's.

Major publishers already involved in the production of CD-I titles include: Time-Life, The Smithsonian Institution, ABC Sports Presents and Mercury Records. And, with the new Photo CD technology available through selected retailers offering KODALUX Processing Services, you can create your own CD family photo albums.

To see and hear CD-Interactive in action, call **1-800-532-6363** to arrange for a demonstration near you. Just five minutes with the Imagination Machine and you'll discover it's more than a CD player: It's an experience!



Tee off in a televised golf tournament. Compose a minuet with Mozart. Let your kids explore Richard Scarry's Neighborhood. Take your family on a private tour of the Smithsonian. And much more. The Imagination Machine and a wide variety of CD-I titles lets you do it all from your living room.

Another First From Philips

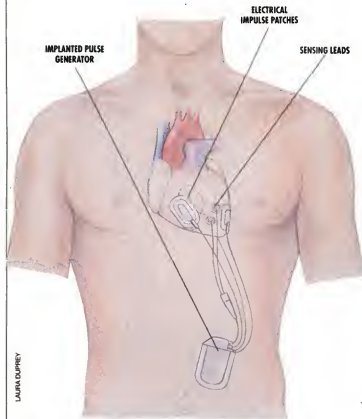
PHILIPS

WHAT'S NEW



PLUG 'N' POLISH

The Waxmaster 912 waxer/polisher's 21-foot cord plugs into your car's cigarette lighter. The motion produced by the unit's 12-volt motor mimics hand waxing without scratching the paint. Price: \$60. The Chamberlain Group, 845 Larch Ave., Elmhurst IL 60126.



THREE-STAGE PACEMAKER

The PCD (pacer-cardioverter-defibrillator) varies the intensity of the electrical impulse administered to a patient's heart, based on the severity of the abnormal beat. Developed by Medtronic of Minneapolis, the experimental device was tapped for approval by a panel to the U.S. Food and Drug Administration.



PERFORMANCE COUPE

Italian cormaker IsoRivolta is planning to introduce a new Formula One-style coupe next year, following a two-decade hiatus from the market. The 1993 two-passenger Grifo will be powered by a 5.7-liter, 435-hp V8, reaching a top speed of 186 mph and accelerating from 0 to 60 mph in 4.3 seconds. Price: \$225,000.



PHONE LIGHT

The Telite-II telephone light automatically illuminates when the phone rings or the receiver is lifted and turns itself off 30 seconds after you hang up. The unit plugs into a phone with the included cable and features a battery backup. Price: \$40. Effective Solutions, Box 29024, Dallas TX 75229-0024.



CD STORAGE FOR CARS

This CD rack has six drawers that support the discs on their edges to prevent scratching. The racks are custom-fit for spare console space in most popular European cars. The latest version (above) is for the Volkswagen Golf. Artur Fischer GmbH, Weinhalde 14-18, Box 52, 7244 Tümlingen/Waldachtal, Germany.



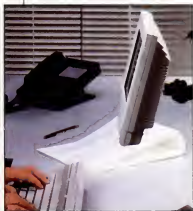
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Black Velvet® Blended Canadian Whisky, 40% Alc. By Vol. (80 Proof) © 1992, Heublein, Inc., Hartford, CT.

WHAT'S NEW



FLAT TERMINAL

When space is limited, the ELT320 terminal takes up one-tenth the space of compatible VT320 terminals. The 4.5-pound unit features an electroluminescent flat display, six local memory pages, local editing, and communication speeds up to 38,400 bps. Price: \$1,425 for ten panels. Planar Systems, 1400 N.W. Compton Dr., Beaverton OR 97006.



RESCUE REMINDER

The electronic voice in the CPR Prompt Rescue Aid guides trained persons through the proper sequences of cardiopulmonary resuscitation at a time when panic may interfere with their memory. The \$300 device was designed for office use. CPR Prompt Corp., 60 Brookdale Dr., Springfield MA 01104.



QUICK-CHANGE TOOL SET

The nickel-cadmium-battery-equipped Power Handle drives four different appliances: a vacuum, reversible screwdriver, flashlight, and blower. The screwdriver has flat and Phillips bits, and the vacuum has four attachments. Price: less than \$100. Focus Marketing Group, 5305 Highpointe Dr., Bloomington MN 55437.



PRONTO PRINTS

Samsung's CP6000 color video printer makes 5.5-by-3.9-inch prints of video images in just 45 seconds, compared with similar printers that take longer than a minute. The unit prints images from televisions, camcorders, VCRs, and laser-disc players. Price: approximately \$1,100.

BLUE-RIBBON YACHT

Built of light alloy and equipped with three gas turbines that drive water jets, the Italian yacht *Destriero* broke the world record for fastest eastbound crossing of the Atlantic Ocean. The yacht, which can cruise at more than 60 knots (69 mph), left from Ambrose Light, N.Y., and reached Bishop Rock, England, in 58 hours and 34 minutes, earning it the Blue Riband prize and the Virgin Atlantic Trophy.



Not All Rayovac Batteries Are Used In Toys.



The premier flight of the space shuttle Endeavour,
NASA's most successful mission ever.

When the space shuttle Endeavour climbed into the beckoning sky, it carried aloft the ultimate in state-of-the-art technology—including a specially-designed Rayovac battery.

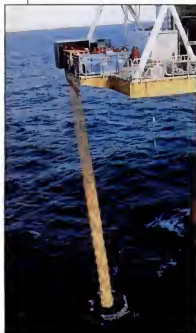
Our advanced engineering made us a natural choice for the mission. That same high technology is yours in all Rayovac batteries. It's there every time you turn on your personal stereo or your kids send a remote control fire truck careening across the carpet on an emergency call. Rayovac turns in one of the best performances on earth or off it.

RAYOVAC®

When Performance Really Counts.



WHAT'S NEW



SAFETY SLIDE

The Skyscape chute was designed for fast evacuations of North Sea oil rigs. Inside the tube of netting, a series of slides forms a zigzag path to help control a person's rate of descent. Made by Selantic Industries of Selje, Norway, the chute has a 25-man rubber raft at its base that inflates when it hits the water.

MINI CABRIOLET

With a sticker price of \$20,000, the ten-foot-long Rover Mini features a sporty 61-hp engine, fat tires under floored wheel arches, a wood-grain dashboard and interior trim, leather steering wheel, auxiliary driving lamps integrated into the front bumper, and a four-speaker stereo. Rover Cars, External Affairs, Conley Rd., Coventry CV5 6QX, England.



BIKE INNOVATION

These swiveling handlebars shrink the width of a bicycle for easier storage or transport. The retrofit stem separates the handlebar clamp from the expander tube; turning a lever rotates the bars. Available in Switzerland for about \$35. We-Ro, Giessereiweg 2, 5703 Seon, Switzerland.



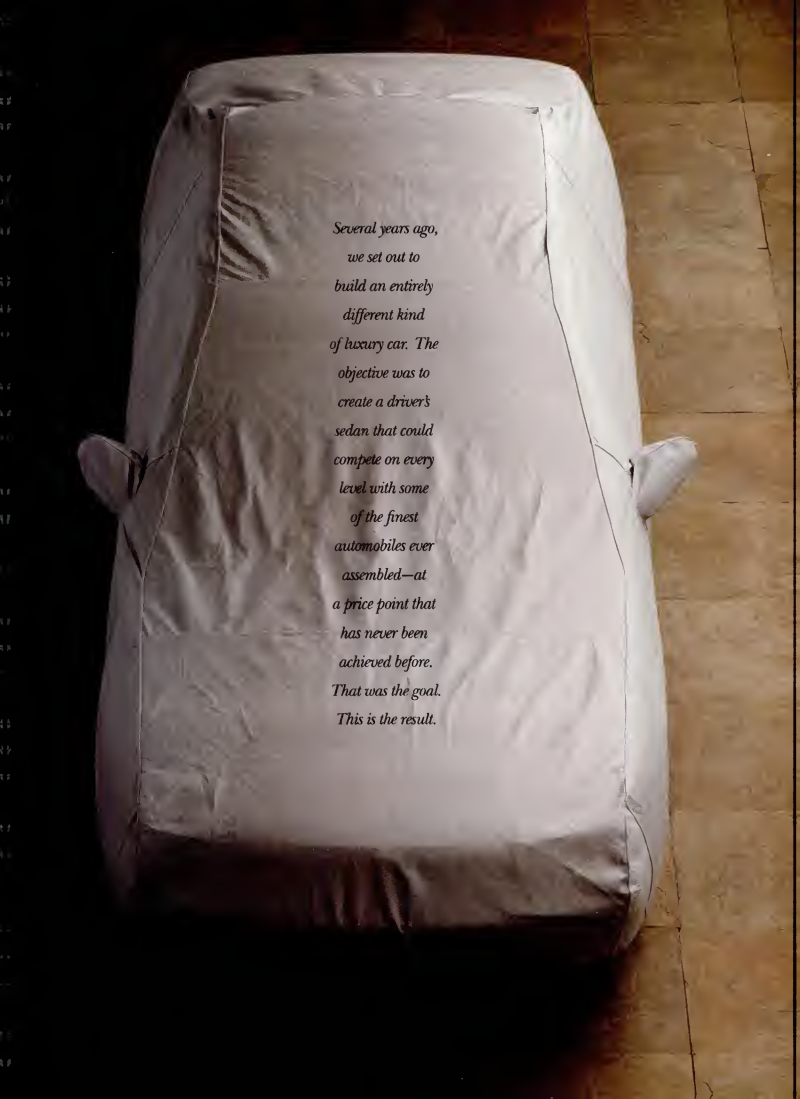
TOOL-TOTING KNAPSACK

More than 100 hand tools slip into this multilayer backpack with padded shoulder straps. Designed for technicians, mechanics, and marine engineers, the S90 rugged-nylon Tool Pak has six fold-out panels and two external pouches. A set of handles lets users carry the backpack, when unzipped, like a tote bag. Paktek Inc., 7307 82 St. Ct. S.W., Tacoma WA 98498.



MUSCLE JET

The most powerful engine ever built for commercial aviation is the Pratt & Whitney PW4084. Designed for the new Boeing 777, the PW4084 is scheduled to begin service in 1995. Its 112-inch-diameter front fan is capable of producing 90,000 pounds of thrust—enough to power two Boeing 737 aircraft. In comparison, engines in service today produce no more than 62,000 pounds of thrust.

A high-angle photograph of a car completely covered by a white, wrinkled protective sheet. The car is positioned on a light-colored wooden floor with visible grain and planks. The sheet has dark straps or ties visible at the corners and along the sides, securing it to the car's body. The lighting is soft, creating subtle shadows and highlights on the fabric of the sheet.

*Several years ago,
we set out to
build an entirely
different kind
of luxury car. The
objective was to
create a driver's
sedan that could
compete on every
level with some
of the finest
automobiles ever
assembled—at
a price point that
has never been
achieved before.
That was the goal.
This is the result.*

Introducing the Nissan Altima.
The affordable luxury sedan.



If you told someone to make a car that had more merging power than a Mercedes 190E 2.3, the agility to out-salom a Lexus ES 300, and the stopping power to out-brake a BMW 325i*—for about half the price of any of these cars—you'd probably

be escorted out of the room by men in little white suits. But that is precisely what the ingenious engineers at Nissan have just accomplished.

The new Nissan Altima[®] is nothing short

of an engineering masterpiece. Every last detail of the car has been closely scrutinized, refined and re-refined over a four-year period. And as a result, the Altima is unlike any automobile ever to come with an economically

feasible price tag.

The thrust of the car comes from a 150-horsepower, DOHC, 16-valve engine that rests on liquid-filled engine mounts. These mounts act as "shock absorbers"—significantly reducing vibration

and engine noise.

Its highly advanced suspension consists of MacPherson struts with optimized anti-dive/anti-lift geometry in the front and multiple links in the rear that further improve driver control. In

Nissan Motor Corporation in U.S.A. Smart people always read the fine print. And they always wear their seat belts. *Based on independent tests conducted by AMCI. 1993 Nissan Altima XE or SE versus 1992 competitive vehicles. Merging power based on time and distance required to accelerate from 20-55 mph. Slalom comparison based on



addition, the front and rear suspensions have been "soft mounted" to anti-vibration subframes.

To translate, this technology makes the *Altima* incredibly powerful and agile. Not to mention remarkably

smooth and quiet. In fact, at 55 mph, the *Nissan Altima* SE's cabin is actually quieter than the cabin of a BMW 325i or a Mercedes 190E 2.3*. Speaking of the cabin, the inside of the *Altima* is graced with

all the luxury and comfort that the outside suggests. Contoured, reclining seats have been meticulously tailored to fit your form. Large, easy-to-read analog gauges adorn the dash. Buttons for the power windows

and door locks** have been precisely placed in the armrest for easy access. And over forty standard safety features have been incorporated, including a driver's side air bag, for your protection. If you'd like more

luxury, a variety of trim levels are available so you can choose from such amenities as a custom six-speaker CD system, an automatic cabin temperature control system, sunroof,



and an optional leather trim interior—to name just a few.

Call us at 1-800-NISSAN 3, and we'll gladly tell you more about the new *Altima*. Or visit your nearest Nissan Dealer where four years of rigorous work can be summed

up in one simple ten minute test-drive.



*The new Nissan
Altima
Starting at \$13,000.***



*It's time to expect
more from a car.**

course completion time. Braking based on stopping distance from 50-0 mph on a wet road surface. Interior quietness based on decibel level. **Standard except on XE models. ***M.S.R.P. for Altima XE excluding taxes, title, license, destination charges, locally required equipment and options. XE model shown with optional alloy wheels.

Finally, proof in advertising.

amci AUTOMOTIVE MARKETING CONSULTANTS, Incorporated

THE LUXURY SEDAN ROAD REPORT

Conducted and certified
by AMCI

Car companies make lots of claims about their cars.

"It's faster." "It's bigger."

"It's sexier." At Nissan, we don't just make claims about the *Nissan Altima*™ – we offer proof. The proof is free. Call 1-800-NISSAN-3, to receive the Luxury Sedan

Road Report. It contains the surprising results of an independent study which shows the *Altima* going head-to-head in emergency and performance road tests against cars like the BMW 325i, the Acura Legend L sedan, and the Mercedes-Benz 190E 2.3. Think of it as the study that demonstrates that luxury and affordability are not mutually exclusive.

For your FREE Luxury Sedan

Road Report call:

1-800-NISSAN-3
ext. 327

*The New Nissan
Altima*



*It's time to expect more
from a car.™*

WHAT'S NEW



SAME GAME, NEW FRAME

The circular Centre Chess follows almost the same format as the traditional game, except for two green "passing zone" wedges and red "no man's zones." As a result, the rook moves in an arc and the bishop in an S-shaped path. Price: \$25. Amerigames International, 15 Barlow Ave., Glen Cove NY 11542.



COLORFUL DEFENSE

DYEWitness sprays a green, foaming dye that obscures vision and leaves a stain on the skin that lasts for days—a potential aid in identifying a criminal. The \$20 device shoots the nontoxic liquid up to seven feet away. KLR Enterprises, 8190 Beechmont Ave., Suite 309, Cincinnati OH 45255.



COMPACT SPORTS COUPE

Based on the 3-series coupe, the new BMW M3 has a six-cylinder engine that develops a maximum torque output of 236 pound-feet at 3,600 rpm. Currently scheduled for launch in Germany, the car is being evaluated for the American market.



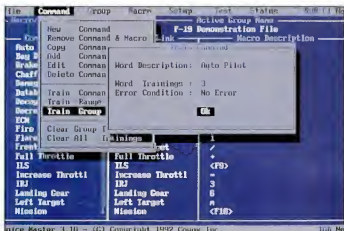
CLEANER CANS

This six-pack beverage carrier snaps over the top of each can, blocking dirt from the drinking lip. Made of recyclable polyethylene terephthalate plastic (PET), the rigid, one-piece Clean-Top carrier replaces the flexible rings that can entangle wildlife. Formo-Pack, 2380 N. Wilcox Rd., Stockton CA 95215.



ROUTER ROSETTES

Sears' Craftsman Rasette Maker attaches to most router tables to make authentic architectural corner blocks, checker pieces, wheels, or drink coasters. Using blanks up to six square inches, the \$40 device carves rings from zero to three inches in diameter and as deep as $\frac{1}{2}$ inch. It should be available early next year.



COMPUTE ON COMMAND

Voice Master Key 3.1 software instantly equips your PC with voice recognition capabilities. The system learns up to 1,000 common commands such as "print this to laser." The package, including a sound card, speakers, microphone headset, and 3.1 software, costs \$200. Cavox, 675 Canger St., Eugene OR 97402.

WHAT'S NEW

AERO-DYNAMIC SHELL

The Aerocoupe Body Shell Kit is designed to top man-powered or light electric vehicles. The 100-inch-long plastic shell includes a removable acrylic canopy with two halves: the front windshield and rear hatch cover. The shell weighs less than 25 pounds and can be modified to fit different chassis layouts. Price: \$695. Blue Sky Design, Box 2014, Thousand Oaks CA 91358.



TINY TOUCH-SCREEN

The UnMouse, a pointing device sold to notebook computer manufacturers for use in their machines, replaces a mouse or track ball. Pressing the 2-by-3-inch touch-sensitive glass tablet moves the cursor; tapping the glass selects on item. MicroTouch Systems, 55 Jonspin Rd., Wilmington MA 01887.

SECURITY SCREENS

A window screen with an electrically conductive polymer pattern is actually a security sensing device.

The Alarm Screen plugs into a security system and triggers the alarm when it's tampered with. The screen will be available next year for about \$50. Alarm Screens, Box A, Tuxedtown PA 18087.



KID-FOILING LIGHTER

The Cricket Electronic disposable lighter has a two-part child-resistant mechanism: Users push in a small tab, then press down the piezoelectric ignition lever. The lighter automatically resets itself; for additional safety, the flame height is fixed at less than two inches. Price: about \$1.



3-IN-1 WEIGHTS

Because the weights inside these hand-held exercise bars are unevenly distributed, changing your grip from the heavy end to the middle area or light end increases the load of the weights for a more strenuous workout. The Swing Weights cost \$22 a pair. WRS SportsMed, Box 21207, Waco TX 76702.



IMPOSSIBLE BINOCULARS

Hold a pair of 20-power binoculars and focus clearly? Impossible. At that magnification, hand tremor fuzzes the image. Yet the Carl Zeiss 20x60 S binoculars can be used without the jitters. The secret: an opto-mechanical system that enables the optical components to sway in synch with hand motions. Price: \$4,725.

FINALLY, AN INNOVATION IN AUDIOTAPE TECHNOLOGY THAT CAN BE SEEN.



Starting this fall, Maxell audiotapes will appear in packaging designed to revolutionize audiotape selection. While you probably know that the different bias levels in today's audiotapes are meant for different recording requirements, you may not be sure which one to choose for each taping need. To simplify the selection, we created a coding system as easy as 1-2-3.

● Tape with a blue dot denotes the first category of bias level: "Normal." It's great for general taping purposes. Like music off portable audio equipment or clear FM broadcasts. Even a spoken lecture.

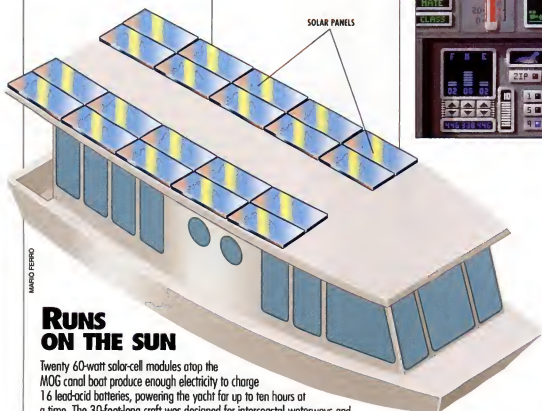
■ A red square stands for the second and most popular category of our tapes: "High" bias. It includes XLII and XLII-S, which has Black Magnetite, and is the perfect choice for capturing the high energy music of CDs.

▲ The purple triangle symbolizes the third and final category of bias level: "Metal." It's excellent for recording powerful, full-spectrum digital source music, live or studio. Before buying one make sure your tape deck has a "Metal/Type IV" setting.

When you make audiotapes with the sound clarity of Maxell, there's no sense in covering them with packaging that's unclear.

maxell.
TAKE YOUR MUSIC
TO THE MAX.

WHAT'S NEW



MARIO FERRO

RUNS ON THE SUN

Twenty 60-watt solar-cell modules atop the MOG canal boat produce enough electricity to charge 16 lead-acid batteries, powering the yacht for up to ten hours at a time. The 30-foot-long craft was designed for intercoastal waterways and reaches speeds of three to five knots (approximately 3 to 6 mph). MOG Canal Boats, 5413 Hounds Ear Place, Raleigh NC 27606.

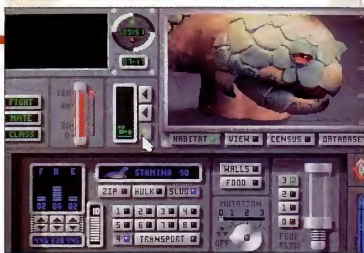


LASER-GUIDED SAW

To prevent misaligned cuts, Porter-Cable's model 7700 ten-inch miter saw incorporates a bright laser line that indicates where the cut will be. The saw handles 2x6 boards cut at 90 degrees and 4x4s at 45 degrees. Price: \$634. Porter-Cable, 4825 Highway 45 N., Jackson TN 38302.

COMBO WORKOUT

NordicTrack's Aerobic Cross-Trainer combines three of the most popular exercise machines in one: a cross-country skier, stair-stepper, and treadmill. The stair-stepper folds out to face you when you're on the treadmill. Up to three user profiles can be programmed into the Personal Performance Monitor, which records weight, sex, age, and leg-resistance settings and then tracks pulse, speed, time, distance, and calories burned during a workout. Price: \$1,199.



BEASTLY BATTLES

UnNatural Selection: An Experiment in Genetic Warfare challenges you to create artificial life. Study the planet you are invading and then decide what characteristics would be most beneficial in your army of artificial beasts. In your laboratory you breed and train various creatures for the ultimate battle. Price: \$70. Buena Vista Software, 500 S. Buena Vista St., Burbank CA 91521.



DUAL-MODE CAR PHONE

Available in the 1993 Lexus LS400 sedan and SC300/400 sport coupes, the Portable-Plus three-watt cellular phone unlocks from its center console cradle/charger for use as a 0.6-watt portable flip-phone. The unit has digital noise reduction for in-car use, speed-dials up to 101 numbers, is voice-activated, and can be trained to recognize two voices.

Cal Lewis



Panasonic GAOO™ SuperFlat™
System Television. Not Just A
New Television, A Whole New
Television Technology.

Your sense of vision and hearing seem to have been enhanced.

You're experiencing the Panasonic GAOO SuperFlat System Television.

GAOO means advanced television technology.

GAOO™
SUPERFLAT SYSTEM™

Artificial intelligence circuitry. Our flattest screen. High-contrast

black glass. It all combines to produce an image with intense, powerful color. And it's capable of generating a picture with over 700 lines of resolution.* But mere words can't describe the Panasonic GAOO SuperFlat System's picture.

You must hear this new Panasonic GAOO SuperFlat System Television. Its audio specs might impress you. But they can't compare to hearing its Active Dome Speaker System. It creates incredible

stereo sound that seems to emanate from the screen.

The Panasonic GAOO SuperFlat System. To appreciate it, you must experience it for yourself. ■

*Depending on source



**PANASONIC INTRODUCES
GAOO SUPERFLAT SYSTEM TELEVISION.
TO APPRECIATE IT, YOU MUST
EXPERIENCE IT FOR YOURSELF.**

Panasonic®
just slightly ahead of our time.®

WHAT'S NEW



REMOTE-CONTROL PHONE

Built-in volume control buttons in the triangular base of the Beacom 1500 phone enable the user to mute audio or video equipment that might otherwise interfere with the conversation. The S200 telephone is compatible with Bang & Olufsen products and has a ten-number memory. Bang & Olufsen of America, 1150 Feehanville Dr., Mount Prospect IL 60056.



PAPER WONDER

With a 28-foot wingspan, this craft—built by high-school students from Hampton, Va.—broke the record for longest paper glider. The plane was launched from a ten-foot platform and traveled 106 feet; moments later, with the wingspan extended by 2.5 feet, this version flew almost 115 feet. The project was sponsored by the American Institute of Aeronautics and Astronautics.



DESKTOP WATER SCULPTURE

The 21-inch-high Water Panel II aquatic sculpture features shimmering bubbles that continuously funnel through 12 vertical chambers. Tricolor near-heat strips slide into the base to create a rainbow of effects when illuminated by a fluorescent light hidden in the base of the unit. Price: \$150. Midwest Tropical, 3700 W. Morse Ave., Lincolnwood IL 60465.

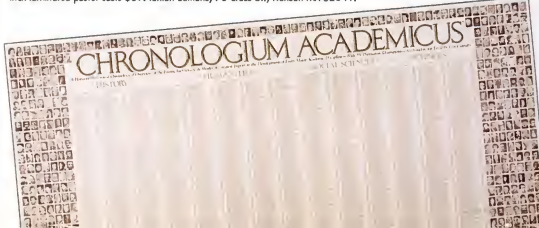


LENGTHENED SEDAN

The Volkswagen Vento, replacing the Jetta, is 172.5 inches long—2.5 inches longer and nearly an inch wider than the old sedan. It boasts a 19-cubic-foot trunk and expanded luggage space by lowering the 2:1-split rear seat. A six-engine lineup is topped by the 2.8-liter VR6, a narrow V6 delivering 174 hp. The Vento offers air bags for the driver and front passenger.

LINKING EVENTS IN TIME

The imposing Chronologium Academicus is a compendium of history organized in rows and columns. The subject-based columns list major events from 50,000 B.C. to the present, and each row represents the same period in history. The 54-by-77-inch laminated poster costs \$89. Ionian Editions, 70 Cross St., Hanson MA 02341.



The Minivan Company.

*One automotive company
has earned that title.*

*The company that in 1984
invented the minivan.*

*The company responsible for such
technological innovations
as the first minivan airbag
and the first built-in child seat.*

*The company that has sold
more minivans than all other
companies combined.*

*The Minivan Company.
It has a more formal name:
The Chrysler Corporation.*



Ask any of the three helped make Chrysler



1993 Plymouth Voyager SE

Ask the woman
who baby-sits in one.



1993 Plymouth Grand Voyager LE

Ask the family
in a Honda



1993 Chrysler Town & Country

Ask the engineer who hadn't
owned an American car
in over ten years.



1993 AWD Dodge Caravan ES

Ask the maga
one to the

Dodge Caravan and Plymouth Voyager
were this country's first minivans.

Ten years later, they're still America's first
choice. And no one else even comes close.

The McDonough clan can tell you why.
They own six Chrysler minivans.

With our minivan airbag, rear shoulder
belts and our anti-lock brakes,* America has
chosen us for the safest of reasons.

Ask the Cartwrights, who ran right into a
concrete abutment. And walked away with
only a few bumps and bruises.

million owners who've The Minivan Company.™



who used to be
commercial.



1993 Dodge Caravan ES

Ask the family
that owns six.



line that took
Arctic Circle.



1993 Dodge Caravan SE

Ask the family who survived
a collision in one.

Thanks to Town & Country, Chrysler minivans have been selected for the most luxurious of reasons, as well.

Just ask David Tarnosky. His '92 Town & Country is the first American vehicle he's owned since 1979.

And our choice of lengths, seating options and built-in child seats* have made us a natural for growing families everywhere.

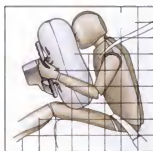
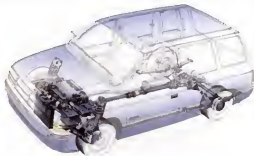
Three million owners can tell you why.

*Call 1-800-876-MINIVAN and tell us your story.
Maybe we'll use it, too.*

To buy or lease, see your Dodge or Chrysler-Plymouth Dealer.

The Minivan Com

1984 Chrysler introduces the minivan. **1985** Selected as one of the "Ten Best Cars" in America by *Car and Driver*. **1987** V-6 power and a long wheel base model. *Automobile Magazine* "All-Star." **1988** 1,000,000th Chrysler minivan sold. *Automobile Magazine* "All-Star" and a *Family Circle* "Family Car of the Year." **1989** *Automobile Magazine* "All-Star" and *Motor Trend* "Ten Best." **1990** 2,000,000th Chrysler minivan sold. Town & Country, the first luxury minivan. *Automobile Magazine* "All-Star" and *Motor Trend*

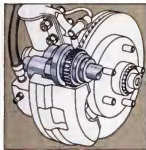


Plymouth Voyager

pany: A History.

"Ten Best." **1991** The second generation of America's best selling minivan debuts. Chrysler offers anti-lock brakes, all-wheel drive and quad seating. And introduces the first minivan driver's airbag.[†] *Automobile Magazine* "All-Star" and *Motor Trend* "Ten Best." **1992** 3,000,000th Chrysler minivan sold. The built-in child seat, *Motor Trend* "Ten Best" and a *Prevention Magazine* "Safe Car of the Year." **1993** Ten model years and still number one. With the highest owner loyalty rating of any minivan on the road.*

See limited warranties at dealer, exclusions and restrictions apply.



[†]Ask about available V-6, built-in child seat, anti-lock brakes, all-wheel drive and quad seating. Our standard driver's minivan airbag provides added safety when seat belt is worn. So buckle up for safety. *1991 Minivan Owner Loyalty Study, R.L. Polk & Co., July 1992.



Call 1-800-876-MINIVAN for more information.



Dodge Caravan

Chrysler Town & Country



"I'D HAVE TO GO 30 YEARS WITHOUT MISSING A PUTT

"Let's face it, on most days, I'm lucky to go three holes without missing a putt. So when I say 30 years, I haven't gone off the deep end."

"I'm just making a point about the unbelievably high quality standards that Motorola Cellular sets for itself."

"The fact is, they're among the highest in the world."

"And since Motorola cellular phones are made so well, it should come as no surprise that they're the world's best sellers, delivering the kind of customer satisfaction nobody else can match."

"Motorola. It's an American company setting standards of quality the whole world can shoot for."

"Something that gets a big thumbs up from me."

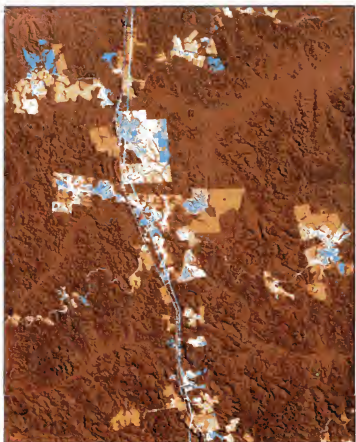
TO HIT THE QUALITY STANDARDS MOTOROLA SETS FOR ITS CELLULAR PHONES."



MOTOROLA
Cellular Telephones

Science Newsfront

Edited by DAWN STOVER



These satellite images show a portion of Mount Hood National Forest in Oregon (left) and an area north of Manaus in Brazil's Amazon Basin (right). In both images, ancient forest areas are dark red. Areas of regenerating forest are lighter red, and recently deforested areas are blue-green.

Twin peaks

While U.S. environmentalists and government agencies lobby against the destruction of tropical rain forests, developing countries are urging the United States to take a look at its own backyard—the Pacific Northwest. The view from 437 miles up is not pretty.

Satellite images processed by scientists at NASA's Goddard Space Flight Center, using data collected by the Landsat-5 Thematic Mapper, show a pattern of clear-cutting in the Northwest that appears far worse than deforestation in the Amazon Basin. At least 85 percent of the Northwest's primary forests have been logged, while only 11 percent of Brazil's Amazonian rain forests are gone.

The images above show two areas of similar size—one in Mount Hood National Forest in Oregon, and the other in an area north of Manaus in the Brazilian state Amazonas. The computer-enhanced images measure the amount of light reflecting from the ground: Areas of ancient forest are dark red; areas of regenerating forest

are lighter red; and areas that have recently been deforested are blue-green.

Forest Service officials point out that U.S. national forests are replanted after logging, whereas Brazilian forests are typically burned to make way for farms and ranches. According to the Forest Service, many of the blue-green areas in the Oregon image contain trees that are a few years old. "Almost every one of those areas that appear to be clear-cuts have been replanted," says Roger E. Crystal, the Forest Service's head of surveying and mapping for Oregon and Washington.

Environmentalists argue that replanted areas are "tree farms" that harbor fewer wildlife species than virgin forests and are less resistant to erosion, insect infestations, and fire.

The checkerboard pattern is a result of Forest Service rules restricting clear-cuts to 60 acres. "The remaining primary forest is highly fragmented," says Brent Holben, a physical scientist at Goddard. "That may be detrimental to plant and animal species diversity."

The two lines running through the Brazilian forest are a power line and a

road. In the Oregon image, the horizontal line is a power line, and the vertical line marks the boundary of the national forest. Just west of the point where the boundary line makes a sharp turn is Timothy Lake, which is about two miles wide. The Pacific Crest National Scenic Trail passes along the east side of the lake.

Gone fishin'

At first it doesn't sound like a great idea: fishing line and nets that degrade in water. But according to the EPA, U.S. fishermen discard 136,000 tons of netting at sea every year. And recreational fishermen may lose or improperly dispose of 20 percent of the fishing line they use. These products pose a serious threat to fish and wildlife and can become entangled in boat propellers.

To solve these problems, researchers at Pennsylvania State University have engineered a new material, called Earth Guard, that degrades in water. Bernard Gordon III, an associate professor of polymer science, created the new polymer by adding weak links of

NASA / GODDARD SPACE FLIGHT CENTER

Science Newsfront

suture material into a long, sturdy chemical chain of polyethylene terephthalate, a plastic used in everything from fishing line to soda bottles.

Earth Guard's rate of degradation can be controlled by varying the percentage of the weaker component, so that a finished product might degrade in a month or in a year, at higher or lower temperatures, as needed.

The new polymer may eventually be used in disposable diapers, surgical gowns, garbage bags, six-pack rings, and virtually any other disposable plastic product. Penn State has applied for a patent, and Pittsburgh-based Brown Bear Bait has licensed the hydro-degradable fishing line. Polymer Chemistry Innovations, a company founded by Gordon, holds the license for all other applications. —Jeff Wallach

Elvis sighting

Chemists at the University of California at San Diego (UCSD) have discovered a way to print photographic images on silicon. To demonstrate the technique, they reproduced the faces of George Washington, Elvis Presley, and a UCSD graduate student.

The technique could eventually be used to design computers and other electronic devices that rely on light to store and transmit data. Computers

now rely on silicon's electrical activity to encode information, but because light travels between computer chips much faster than electricity, researchers would like to build silicon-based devices that emit light.

In recent years, scientists have discovered that porous silicon can be made to give off light. A piece of silicon is connected to a wire, then placed in an acid bath. When a current is passed through the wire, the acid begins to bore holes into the silicon. If this electrochemical corrosion continues, the holes expand and merge, creating a "forest" of tiny silicon trees that emit light. Some scientists have hypothesized that the silicon forest glows because its narrow tree trunks—about two billionths of a meter wide—confine electrons to high energy levels.

"We found we can take silicon wafers and, instead of just etching them, we can use light to modify the etch rate," says Michael J. Sailor, an assistant professor of chemistry at UCSD. When he and graduate student Vincent Doan projected light through a film negative onto silicon during the



This image of Elvis is etched on a porous silicon film. The color of light reflected at each point depends on the film's thickness.

etching process, deeper holes formed where the light intensity was greatest. "You get a film of porous silicon that has different thicknesses," says Sailor.

The colors are reflections of light that vary with the thickness of the silicon film. "Just as Wesson oil has no color to it, when you put a thin layer of it on water you will see colors," explains Sailor. "The colors change as the thickness of the oil changes."

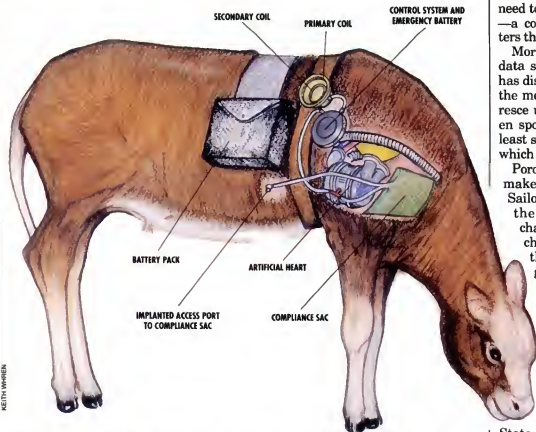
It is possible that silicon etchings could one day be used to archive images, replacing photographs that fade over time. But researchers would first need to find a way to prevent oxidation—a corrosion process that quickly alters the thickness of the porous silicon.

More promising applications are in data storage and transmission. Sailor has discovered that pictures created by the modified etching process will fluoresce under ultraviolet light. Any given spot on the silicon can give off at least six distinct colors of light, each of which could convey data.

Porous silicon could also be used to make disposable chemical sensors, Sailor says. Under ultraviolet light, the color of the etched silicon changes as it is exposed to different chemicals. In water, for example, the silicon gives off an orange glow. But when ethanol is mixed with the water, the glow disappears. Because of this effect, the silicon could be used in a breath analyzer.

Winston's wireless heart

Artificial-heart technology took a big stride forward when researchers at Pennsylvania State University revealed photos of Winston, a five-month-old calf with a wireless artificial heart.



A copper coil strapped to this calf transmits electricity to a second coil implanted under the skin, powering a wireless artificial heart. The compliance sac compensates for changes in barometric pressure.

Introducing The Sharp TwinCam.

With Two Lenses, It Does What No Single Lens Camcorder Can.

**PICTURE-IN-PICTURE
ONE-TOUCH INSTANT 12X ZOOM
BUILT-IN 62° WIDE-ANGLE LENS**

Finally, someone has created a camcorder with distinct advantages. The remarkable TwinCam™ from Sharp.

The only camcorder in the world to build two lenses into one sleek, lightweight design.

The first lens is an *exclusive wide-angle lens* — to capture an entire scene, not just a part of it. The second lens is a powerful zoom lens — to catch small but important details.

Together, these two lenses let you combine wide-angle and close up shots in one frame with TwinCam's unique *picture-in-picture* feature. Or switch between the two scenes at the touch of a button, creating an *instant 12X zoom*.

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THE SCIENCE OF MAKING MONEY

Is there a hidden pattern in the chaos of wildly fluctuating stock markets? That's the hope of six university and government physicists who quit their jobs to form their own company. Bucking economic dogma, they are attempting to use the new science of chaos to predict stock performance.

Traditional economic theory holds that financial markets react instantaneously to new information, then quickly settle down. Because analysts can't anticipate breaking news, oscillations in the prices of stocks, bonds, and other securities are random, and hence unpredictable.

Until recently, any other possibility seemed like a pipe dream. But in the late 1970s, physicists discovered chaos—complicated behavior that seems random but actually has an underlying order and can be described by mathematical formulas. In the following years, they found evidence that animal population growth, voltage fluctuations in circuits, day-to-day changes in weather, and many other complex phenomena that appear random might actually be chaotic.

The widespread applicability of chaos has given some researchers hope that subtle patterns also lurk behind swings in the securities market. Perhaps markets re-

lists at the company will not divulge any operational details. However, Doyne Farmer, vice president for research, explains that they use a technique formidably named "state space nonlinear time series prediction." Roughly, this involves making a mathematical map that compares the present value of a variable with its value at selected times in the past. The map reveals patterns that otherwise might not be seen.

Here's a vastly simplified example: Suppose you want to predict Friday's Dow Jones Industrial Average, and you know the Dow's closing values on Monday through Thursday. You make a graph comparing the average on each day with the previous day. The first point plots the value on Tuesday versus Monday, the second point plots Wednesday versus Tuesday, and so on. Then you look for an equation showing how the points change over time.

In actuality, the Prediction Co. uses price data going as far back as 20 years and compares up to 40 different variables at once on high-speed computers. Farmer says it will be at least another year before he and his colleagues know whether their techniques work.

Outside the company, many chaos researchers are optimistic that the tech-

Until recently, artificial heart mechanisms—replacements for diseased or weakened natural hearts—required wires strung to bulky bedside equipment, limiting patients' freedom of movement. But recent advances in batteries and electrical transmission systems may allow future artificial heart recipients to live much more normal, physically unrestricted lives.

Last year, for example, doctors at the Texas Heart Institute in Houston announced that a patient had received a battery-driven heart-assist device, which acts like an extra pumping chamber for debilitated heart muscles [*"The Bionic Heart,"* April]. Now, say the Penn State researchers, they have gone one step further by combining a wireless power system with a completely mechanical heart.

To power the artificial heart, electricity is transmitted through the skin via a pair of copper coils—one implanted and the other lying against the skin's surface. This method, say the researchers, eliminates any punctures in the skin that could spread infections.

The danger of infections is real: After receiving the experimental heart on March 24, Winston died 118 days later of an infection that began because of a wire passing through the skin. The wire had been used to monitor the artificial heart. Alan Snyder, a research associate in the surgery department, says the Penn State team plans to repeat the experiment, using a wireless radio transmission system for monitoring purposes. Snyder says clinical trials of battery-powered artificial hearts may begin before the turn of the century.

—Judith Anne Yeaple

Microscopic battery

What's the smallest battery you can think of? The one in your watch or hearing aid? Forget about it. Chemists at the University of California in Irvine (UCI) have built the world's smallest battery, one-hundredth the size of a human red blood cell. Its longest dimension is a mere 700 angstroms (ten-billionths of a meter).

Reginald Penner, a UCI assistant professor of chemistry, describes the device as a "galvanic cell" made of tiny pillars—either silver or copper—deposited on a graphite surface by a scanning tunneling microscope. When the surface, bearing its tiny pillars, is immersed in a dilute plating solution of copper sulfate, the copper pillars spontaneously dissolve, and copper ions plate onto the surface of the silver pillars. The reaction generates 20 thousandths of a volt for 45 minutes. That is a third of the voltage



Doyne Farmer (left) and Norman Packard use chaos theory to forecast financial markets.

act to new information in a complicated way, fluctuating up and down for days or weeks. By finding equations describing these fluctuations, scientists might be able to make short-term forecasts.

That's the goal of the Prediction Co. in Santa Fe, N.M., formed in September 1991 by six former physicists from Los Alamos National Laboratory in New Mexico, the University of Illinois at Urbana-Champaign, and the University of California at Santa Cruz. During their academic careers, these researchers used chaos theory to predict everything from fluid flow to ice ages. In one project, they used seven years of sunspot activity to forecast the eighth year, with an error of about 30 percent—much more accurate than traditional prediction methods.

To keep secrets from competitors, sci-

niques might succeed, but most economists remain skeptical. Says University of Chicago's Eugene Fama: "The chance [of success] is not zero, but close to it."

Despite the uncertainties, banks are exploring nonlinear prediction techniques. The World Bank in Washington, D.C., recently began to use a time series prediction method to manage part of its bond portfolio. The Prediction Co. is close to signing an exclusive agreement with SBC/OC Services, L.P., an options and futures trading house in Chicago.

"[Our work] is just the tip of a very large iceberg," remarks Norman Packard, Prediction's chief research scientist. He foresees "a race to develop increasingly better predictive methods, which will eventually alter the character of the financial markets themselves." —Robert Langreth



A scanning-tunneling-microscope picture of the world's smallest battery shows pillars of silver and copper atoms on a graphite surface. The numbers along the edges give the dimensions of the device in angstroms (ten-billionths of a meter).

used by a human cell to drive metabolic processes such as osmosis.

The UCI battery is unusual in another fundamental respect. It works only because of a bizarre electrochemical phenomenon called "underpotential deposition." Electrons of the two metals have slightly different potential energies, a characteristic called "work function." The difference drives copper ions to deposit on the silver terminal until it is coated with a layer of copper just two atoms thick. Once that happens, with the silver terminal plated with about 80,000 copper atoms, the battery stops working.—Arthur Fisher

The software hiccuped

Millions of television news viewers this past April watched a prototype of the U.S. Air Force's new F-22 Lightning fighter pitch violently out of control, hit the runway at Edwards Air Force Base in California, and skid along for thousands of feet while erupting in flames. Although the report of an official inquiry into the crash has not yet been released, a pilot familiar with the aircraft says a rough spot in its flight-control software caused the mishap.

At the time of the accident, the airplane's engines were in afterburner mode, its landing gear was retracting, and its thrust-vectoring exhaust nozzles were active—a combination of conditions that had not been test-flown before at extremely low altitude.

When its landing gear is lowered, the F-22's software automatically increases the airplane's responsiveness to the pilot's inputs by a factor of about four to make landings safer. The software shift that occurs when raising or lowering the gear is now believed to be too abrupt. Although simulator modeling had predicted the F-22 would be stable during the transition, the com-

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Science Newsfront

puter program wasn't good at factoring in the response to ground effect, which tends to produce pitch changes when the craft is only a few feet above the ground.

The computer-induced instability caused the fighter to dip in and out of ground effect, which led to its severe nose-up, nose-down porpoising. Lockheed pilot Tom Morgenfeld was remarkably lucky. As the F-22 ground to a halt, he clambered out of the cockpit to safety.

The Air Force plans to finish its F-22 test flights with the first production prototypes of the fighter, which are due to fly in 1995.—*Stuart F. Brown*

Sugar tester

Dr. Ries Robinson of the University of New Mexico School of Medicine has good news for the 2.5 million American diabetics who must draw their blood daily for testing. These patients will soon be able to painlessly measure their own blood sugar by inserting a finger into a calculator-size device.

The patented device was jointly developed by the medical school and Sandia National Laboratories in New



This device measures blood sugar by analyzing a beam of infrared light passing through a finger.

Mexico and is based on Sandia technology originally used to detect chemical changes inside aging nuclear weapons. Pulses of infrared light penetrate the finger tissue and are broken into a

spectrum. To determine the amount of glucose absorbed in the blood, the spectrum is evaluated using chemometric data analysis, a form of analytical chemistry that incorporates sophisticated statistical techniques. The analysis compensates for individual variation in finger thickness and skin pigmentation.

Not only does the new device eliminate the need for painful finger-pricking, it also allows for the continuous monitoring of blood sugar during surgery or childbirth.

Robinson says that commercial development of a home glucose monitor could begin early next year. He estimates the monitor will cost about \$2,000, about four times the annual cost of disposable finger-pricking kits.

The medical school and Sandia are testing the feasibility of using infrared light to monitor cholesterol and alcohol in the blood.—*Ray Nelson*

3-D laser show

A flimsy pair of cardboard glasses with clear plastic lenses can transform an ordinary laser show at New York City's Hayden Planetarium into a spectacle.

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lar experience called LaserDrive 3-D. Red, green, and blue images dance across the ceiling, zoom toward the audience from every direction, and spiral away into a black hole.

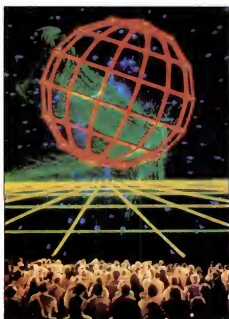
The technology behind the show: ChromaDepth lenses made by Chromatek Inc. of New York City. These lenses enhance the eye's natural tendency to see colors at different distances. For example, when brightly colored red and blue objects are placed at equal distance from a viewer, the red object is perceived to be closer. ChromaDepth lenses exploit this phenomenon, called chromostereoscopy, by dispersing colors at various depths.

To achieve perfect focus, two prisms are needed—a high-dispersion prism singles out the individual colors, and a low-dispersion prism focuses each color. But glasses made with two prisms are costly, heavy, and an inch or more in thickness. The ChromaDepth lenses instead use a holographic film to mimic the effect of twin prisms.

Unlike most 3-D systems, the Chromatek technology doesn't require producers to create two sets of overlapping images. Instead, the ChromaDepth lenses "decode" a single image, which looks two-dimensional when viewed without the glasses.

Audio Visual Imagineering (AVI) of Springfield, Va., produced the first public LaserDrive 3-D show for the Hayden Planetarium. AVI plans future installations at planetariums in Salt Lake City; Chapel Hill, N.C.; Long Island, N.Y.; London; and Toronto.

Other possible appli-



ChromaDepth lenses made from holographic film add a third dimension to laser light shows.

cations for the technology include air-traffic-control displays, advertisements, video games, and greeting cards.

—Suzanne Kantra



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Electronics Newsfront

Edited by JOHN FREE



A listener at the center of an anechoic chamber responds to test signals from surrounding loudspeakers. Data gathered will aid in the development of automatic room-equalization hardware.

Smarter hi-fi

Costly stereo systems that sound superb in a hi-fi showroom may sound dull and flat after they're set up in your living room. The problem: speakers and amplifiers matched to the room acoustics in one location can sound drastically different elsewhere.

Now, tests underway at the Technical University of Denmark are aimed at developing new-generation "smart" audio systems that adapt themselves to the acoustics of a room—regardless of size, shape, and furnishings. The university's acoustics laboratory is working with British loudspeaker manufacturer KEF Electronics and Bang & Olufsen in Denmark for the amplifiers. Researchers hope to improve upon current hardware that equalizes room acoustics.

Starting point for the project: realistically simulating typical listening environments inside a large anechoic chamber at the university's Copenhagen acoustics lab. A trained listener

sits at the exact center of an imaginary 20-foot-diameter sphere defined by up to 24 speakers suspended in space. The speakers are housed in ten-inch-diameter plastic spheres. Just one sphere carries the "real" sound, while the output from the others is delayed a few milliseconds, adding faint echoes.

Sounds can be music, speech, tones, or white noise (a blend of frequencies), transmitted in paired bursts with different echoes. After each pair, listeners signal their responses to differences between the bursts with a yes-no keypad. A computer, which controls the entire system, records the response thresholds. Results from analysis of these data could be integrated into the design of stereo equipment.

While automatic compensation for room properties is still experimental at the university, researchers expect that digital hardware and electronic filters

could respond to self-generated test signals in future equipment. This could alter the frequency emphasis in selected speakers, tailoring the system to the room.

Last year Marantz offered its elaborate computerized room equalizer/controller, the \$15,000 AX-1000, to professionals and audiophiles [Electronics Newsfront, Best of What's New; Dec. '91]. Other hardware, with varying degrees of effectiveness, is available. —David Scott

Cleaning up printers

As laser models replace older printers, environmentalists are complaining about the toner cartridges used by the machines that clutter landfills. Now, Kyocera says its new Ecosys amorphous silicon FS-1500A printer is "ecologically sensitive."

Instead of cartridges, the FS-1500A has a biodegradable toner container that's replaced every 5,000 copies. The container, even if incinerated, will emit only water and carbon dioxide. Also, instead of a short-lived (4,000 to 12,000 copies) OPC (Organic Photo Conductor) drum, the kind most laser printers employ, the FS-1500A uses a drum coated with a thin film of amorphous silicon. Kyocera's silicon-coated drum is warranted for 300,000 copies. One reason for this remarkably long life: The toner has microfine abrasive ceramic particles that continuously clean and polish the amorphous silicon surface.

The FS-1500A is also beneficial to workplace environ-



Biodegradable toner containers plus a long-life drum are featured in Kyocera's new laser printer.

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she crosses the
street, you won't
let her climb to the
top of the jungle
gym and you
make her wear a
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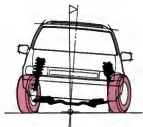


Front cornering lamps provide added side-view illumination when turning at night.

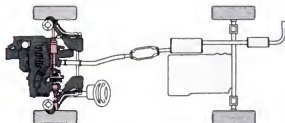


At Nissan we believe the more durable a car is, the safer it is. For instance, to test its durability, the Quest logged nearly one million miles.

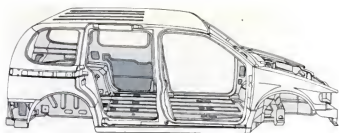
Nissan Motor Corporation in U.S.A. Smart people always read the fine print. And they always wear their seat belts. *Except models with privacy glass.



We took a very level-headed approach to safety. A front stabilizer bar helps keep the Nissan Quest level during cornering or lane changes.



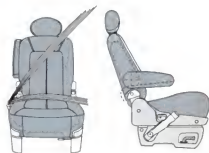
By placing the engine weight over the drive wheels, our sophisticated front-wheel drive provides added traction.



Did we mention the Nissan Quest comes with its own added protection in case of a side impact. And pillar/roof body guards? Steel side reinforcements increase door guard beams provide body rigidity.



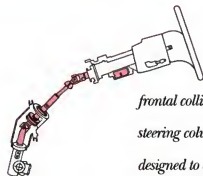
When it comes to braking we didn't stop with our power-assisted brakes. An optional 4-wheel anti-lock braking system is also available.



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ments. In addition to being one of the smallest (13.6 by 8.7 by 13.8 inches), lightest (30 pounds), and quietest (35 decibels) nonimpact printers on the market, it draws less electricity than other models. Its ozone emissions are only 0.002 parts per million, and at ten pages per minute, the Kycera is one of the fastest printers in its class.

Doing away with cartridges and short-lived drums cuts operating costs to three-quarters of a penny per page, which is about one-quarter of a laser printer's average of about 3 cents per page. Kycera claims its printer is more reliable because it uses light-emitting diodes (LEDs) in the FS-1500A rather than a laser-based print engine. It produces a crisp 300 by 1,200 dots-per-inch resolution, quadruple that of the average laser printer.

That odd resolution number is because of the LED head, which is limited to a fixed number of dots for the vertical scan, but can adjust the speed and movement of the horizontal scan, which in turn significantly boosts resolution. Kycera promises even higher resolution on future Ecosys models. The basic \$1,795 machine comes equipped with 79 bit-mapped and 13 scalable fonts built in and can emulate a half-dozen popular printers, including the Hewlett-Packard PCL-5.

Among the options offered are Ky-



Pacific Bell's digital phone network gives realtors fast access to computer images stored at one site.

ocera's version of PostScript, additional fonts, increased memory, an envelope feeder, various stackable trays, and a ten-bin collator. In addition, users may install customized fonts, logos, or graphics by inserting preprogrammed credit-card-size cartridges in the printer's two expansion slots.

—Daniel Grotta

Digital phone lines

A Los Angeles real estate agent shows clients dozens of full-color pictures, including home interiors and landscaping. But these pictures aren't in brochures—they're coming over a phone line, appearing seconds apart. These transmissions are possible because of

486 POWER GOES INTO COMPUTER KITS

IBM-compatible PCs built around 486 microprocessors deliver top computing power these days—until Intel Corp. rolls out its 586 chip, dubbed the P5, next year. While discount prices are falling rapidly for 486-based PCs, building a computer from a kit is one economical way to acquire a high-performance number cruncher. A side benefit is repairs: You're out of luck if the 1.8-million transistors in a 486 chip fizzle. But troubleshooting most problems in a build-it-yourself computer can save time and money.

PC-Build Computer Kits, a small Wellesley, Mass., firm, recently added an i486DX2/50-processor model to its lineup. This chip operates at a blazing 50 megahertz internally, while surrounding circuits run at less than half this speed. DX-series 486s feature a built-in math coprocessor, which speeds programs involving intensive number computations.

Assembling a DX2/50 kit is quick and easy since no soldering is required. Before the prebuilt motherboard is attached to the cabinet, four one-megabyte memory modules are plugged into the board. That leaves four empty card slots for optional memory expansion. A series of color-coded wires and cables from the power supply and front panel are attached. The 5¼-inch, 3½-inch, and hard-disk drives are slid through the panel and connected—with a grave warning that



Kit components can be attached to the computer cabinet and motherboard and other tests completed within four to six hours.

the hard drive can be destroyed if it's plugged in wrong. Another internal drive, such as a CD-ROM machine, can also be added. After plugging in video and disk-controller cards, five expansion slots remain on the motherboard. An optional color video card is Orchid Technology's Fahrenheit 1280°, a graphics-accelerator that supports up to 16.8 million colors and handles Windows applications up to 12 times faster than standard cards. (The DX2/50 is shipped with DOS 5.0, but not the graphically oriented Windows 3.1 "shell" that makes Microsoft's 5.0 operating system easier to use.) One DX2/50 completed recently worked fine, but only after pressing RESET each time the computer

was turned on. The fix from PC-Build's technical support: a new power supply and cabinet. Transferring all the components took about 30 minutes. After a kit is assembled—or for later troubleshooting—a special disk provides either rapid or prolonged tests of computer components. With a 14-inch color monitor, this setup is about \$1,800. Some final steps—installing basic-operation software onto the 130-megabyte hard disk—seemed more complex than building the kit. A popular data-compression program, Stac Electronics' Stacker 2.0, doubled hard-disk capacity. But loading it, along with Windows 3.1, required several attempts and advice from the software firms.—J. F.

Electronics Newsfront

a technique called integrated services digital network (ISDN). With an ISDN connection, faxes, voice conversations, or computer data (including pictures) can simultaneously flow into and out of homes or businesses over one line. By contrast, with a 1,200-bits-per-second (bps) modem, each picture would take at least ten minutes—and monopolize the phone line.

Excruciatingly slow in development, ISDN is finally coming to a handful of large U.S. cities late this year. Most big cities will receive limited service in 1993. In November, local and long distance companies will link a dozen cities in the Transcontinental ISDN Project (TRIP) '92. Planners say these permanent connections will be the core of a network that will span the nation.

American Express, Bank of America, Boeing Co., Hershey Foods and other large companies have used ISDN for years, but only on private networks or in areas within the reach of one phone-company switching office. Now the stage is set for change.

Applications abound for all-digital transmissions, the simplest being faster data transmission and elimination of modems. Credit-card validation takes seconds rather than minutes; ISDN facsimile machines produce a page in three seconds instead of three minutes. A more sophisticated use: Using one phone line, PC users can share screens while talking. Text or image changes on one screen appear instantly on the other screen.

ISDN automatically delivers the caller's phone number, and that fea-

ture underlies the most popular application. A call to a business triggers a search of the company's database. The caller's name, address, and previous contacts with the company—for example, a history of his insurance claims or merchandise purchases—automatically appear on a computer terminal.

ISDN digitizes speech, music, or video. Two 64,000-bps channels and one 16,000-bps channel are placed on the same wires running to your home or business. Because the 16,000-bps control channel can also transmit digital data, you could talk to someone, send a picture from your PC to another computer, and send a fax simultaneously on the same line.

The multibillion-dollar question: Will people buy ISDN? The phones initially will cost hundreds of dollars each, although several can be connected to one line. PC owners will need an adapter, usually a card plugged into an empty slot. Rule-of-thumb pricing for a full ISDN line is 1.5 times the cost of a regular business line. Phone companies reason that at twice the cost, people would buy two ordinary lines.

Incompatible hardware and a lack of commitment have helped delay ISDN for years. This year the Bell companies, which operate 90 percent of the local phone lines in the United States, tried breaking the logjam by releasing ISDN installation schedules for some area codes and exchange numbers.

But the people of Davis, Calif., aren't waiting. Last spring, the University of California at Davis and local businesses drew up a plan for an ISDN-based

"interactive, multimedia/video-text network" that will connect businesses, libraries, government offices, the university, and residences. More than 1,000 individuals and businesses signed up, although Pacific Bell made no commitment to install ISDN. The group circumvented the phone company and went directly to the state utility commission, which regulates local phone service. A spokesperson for the Davis group said that if Pac Bell would not serve them, they would look to other carriers, perhaps a long distance company, to provide their network. Revenues would come from Pac Bell's pocket.—Lee Greathouse

Improving flight safety

When the new CAE Electronics Ltd. flight simulator of a Boeing 747-400 "takes off" at NASA's Ames Research Center in California next year, state-of-the-art technology will create a highly realistic setting in a down-to-earth environment. The full-mission simulator, which mimics Boeing's newest model in the 747 series, is being developed to research ways to reduce aircraft accidents and flight delays by improving human capabilities using automation.

Why concentrate on the human interaction with the aircraft? "Airplane technology has improved exponentially; but humans have stayed the same since flight developed," says Robert Shiner, manager of Ames' Man-Vehicle Systems Research Facility, a center dedicated to aeronautical human agent research. "Human performance issues appear as primary or associated causes in 60 to 80 percent of aviation accidents and incidents," Shiner says.

The simulator will include a "glass cockpit," with all primary displays on CRTs as opposed to the old gauges, switches, and levers. It will test new instrumentation and examine known problems in aviation safety control. One experiment, for example, will use a computer data link instead of voice communications between pilots and air traffic controllers. This method, researchers hope, will eliminate the misinterpretation of certain speech patterns. Reprogrammable displays for stressful and non-stressful scenarios will be conducted with real pilots and air traffic controllers.

Displays are driven by IBM RISC 6000 workstations, which are also used to collect data—up to 2,000 variables at 30 hertz for 10 hours. The computers then preprocess these data to emphasize certain responses. Microphones and hidden cameras also



A pilot's-eye view of the moon is part of the realistic simulation at NASA's Ames Research Center.

capture the pilots' reactions on a VCR.

The researchers realize that many of the experiments, tried for the first time, may not work. "For example, with the data link, we believe that the pilots may lose the 'party-line' effect, so they don't hear all the chatter of the other pilots," says Shriner. That reduces some of the pilots' situational awareness—knowing where they are relative to everyone else.

For the year 2000 and beyond, the Ames facility will add the Advanced Concepts Flight Simulator (ACFS), also dedicated to human factors research in flight performance. ACFS will include futuristic concepts such as computers programmed for error-tolerance systems, where the human is 'allowed' to make errors. Says Shriner: "The airplane computers will be smart enough to question whether you really want to take an action—by voice, text, or graphics on a CRT."
—Patricia Barnes-Svarney

Easier Apples

You're getting ready to tackle tax forms, firing up the family computer to print out some accounting records. But the computer replies, "FILES NOT FOUND." It seems one of your children, tinkering with file commands between adventure games, managed to erase your tax records.

For its new Performa line of Macintosh models, Apple Computer has added software that makes it easier to prevent such disasters. These three family-oriented models, rolled out in September, have a new software "shell" called At Ease. The program makes Apple's graphics-oriented operating system, System 7, even easier to use. In addition to a special password protection feature, At Ease can eliminate double-clicking with the mouse on successive screen icons to locate the file you want. One click does the job.

Apple's simplest Performa model, the 200, is similar to its easily transportable all-in-one Classic. The 200, with a nine-inch monochrome screen, is expected to cost less than \$1,250. The Performa 400, which can display 256 colors, appears physically similar to Apple's LC computer. Without a monitor, the 400 will cost \$1,400 to \$1,500. The high end of the line, the model 600, is available with a built-in CD-ROM drive (\$2,500) and without (\$2,000). The 600 has three expansion slots for plug-in cards, such as video "frame grabbers." Apple's CD-ROM drive is unusual because it handles Kodak Photo CDs. These so-called multi-session discs may be recorded



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Placed in the National Register of Historic Places by the United States Government.



Electronics Newsfront

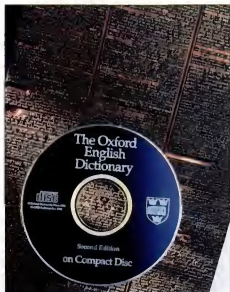
with digitized family snapshots at different times. Most CD machines only play back discs that have one lead-in track describing the disc contents. All Performa models have at least four megabytes of memory and an 80-megabyte hard-disk drive.

English on a disc

A new CD-ROM version of the Oxford English Dictionary (OED) needs only eight seconds to complete a detailed search. The same task once took a student at England's Leeds University six months using the 20-volume bound edition.

The second-edition disc, or OED2, has all the information of the 137-pound, \$2,750 printed set including 616,500 defined words and terms, plus 2.4 million illustrative quotations, etymologies, and cross-references.

Microsoft's Windows features are built into the OED2 disc to simplify its use. You can click on different menus and open several files at once, pasting information onto a screen "clipboard," or calling up search words from other Windows applications. The windows also work as filters, enabling you to get



Improved retrieval software plus Windows capabilities enhance a new CD-ROM dictionary.

progressively more specific about references from the disc.

Oxford University Press worked with AND Software b.v. of Rotterdam, The Netherlands, to compress the data used for the two-disc OED released in 1988, and added new search and retrieval software. Most disc space on

the OED2 is occupied by the detailed indexes used by the search program.

Users can search for words by time period, definition, phrase, etymology, and quotation. Searches can be limited to certain authors, publications, and text quotations with a specific frame of reference, such as those in one subject or time period. A unique feature of the software is the wild-card search, similar to a reverse dictionary, which looks for words and quotes when the user can only supply a partial spelling, definition, or reference.

The \$895 OED2 requires an IBM or compatible PC with at least an 80386 processor, plus Windows 3.0 or higher. An Apple Macintosh version is slated for early 1993.—Todd Heth

Mimicking the brain

For crunching through step-by-step computations, the human mind is no match for the blistering speed of a computer. But when it comes to recognizing patterns or learning from mistakes, computers stumble over tasks that children handle easily.

Computer scientists have been trying to surmount these limitations by

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replicating the brain's neuron and synapse structure in computers. When a neuron in the brain is stimulated, it transmits impulses across the synapses to all surrounding neurons. Computer designers are trying to imitate this process with neural networks, which are sometimes crafted in software and in special neuroprocessors ["Brain-Style Computers," Feb. '89].

Ricoh Co. engineers have now developed what they claim to be the first neurocomputer that relies solely on a network of neuroprocessors. The network has three layers. In the input layer, devices distribute each input signal to each of the 16 processors in the middle layer. Each processor performs a mathematical operation assigning different weights to each of the signals it receives. If the mathematical operation yields a certain threshold value, a signal is fired to each of the 16 processors in the output layer, where the mathematical operation is repeated.

The first time through any task, the weights assigned to the input signals are picked at random. But if the final output is incorrect, an error signal is transmitted back through the network and the weights are altered. This process is repeated until the final output is correct. This enables the computer to "learn" to recognize patterns or control processes without being programmed like conventional computers.

At a demonstration, Ricoh used its neurocomputer to control a mobile robot. Without any programming, the robot was walked through a maze and the computer was taught that, for example, when the robot's sensors spotted walls ahead and to the left, the correct response was to turn right. After being taught the course once, the computer could maneuver the robot through the maze without an operator supervising the turns.

Morio Onoe, general manager of Ricoh's research and development group, says the advantage of forming a neural network out of processors is speed. The company is working on a second-generation neurocomputer based on a more advanced processor, which they claim will be far faster for certain tasks than massively parallel computers.

Researchers at Ricoh's California Research Center in Menlo Park have been working with colleagues in Japan to develop the LSI RN-200 neurocomputer chip. Ricoh foresees using neurocomputers in industrial process control and in image, voice, and object recognition. The company claims it is a step toward giving a computer the learning and decision-making capabilities of the human brain.—Dennis Normile



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The 1993 Caprice features state-of-the-art, front and rear "crush zones" that are specifically designed to "crumple" and help absorb the impact of a collision.



You'll also benefit from the rigid safety cage construction that completely surrounds the new Caprice's entire passenger compartment.



full-perimeter steel frame or its driver's-side air bag, we think you'll agree that this car has been very well thought out. Inside and out.

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No matter how you look at it, you can feel confident.

As you can see, our engineers have clearly designed the 1993 Caprice with your safety in mind. Whether it's Caprice's



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OF AMERICA™**



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NATIONAL **ENVIRONMENTAL** FORUM

Times Mirror Magazines
VOTERS' GUIDE TO
ENVIRONMENTAL
ISSUES



The choice between natural resource conservation and degradation is in your hands when you vote on November 3. This Guide brings you the information you need to balance environmental protection with economic progress in the voting booth.

IT'S IN YOUR HANDS

The 1992 elections will help decide the future of the environment in this country—and the world. The choice is in your hands.

**FIELD
STREAM
GOLF
MAGAZINE**

HOME MECHANIX

OUTDOOR LIFE

**Popular
Science**

**Salt Water
SPORTSMAN**

**SKI
SKIING**

STN

**SPORTING GOODS
DEALER**

**TOURNAMENT
DIGEST**

Yachting

We appreciate GMC Truck serving as the participating partner in the publication of this Voters' Guide. For more information about the Times Mirror Magazines Conservation Council, please write: Dr. David B. Rockland, TMM Conservation Council, 1705 DeSales St., N.W., Washington, D.C. 20036.

Most of the readers of our magazines enjoy the outdoors. But the ability to continue doing so depends on a healthy environment. Because the environment faces threats from a variety of sources, we have taken stands on natural resource issues important to our readers.

When you step into the voting booth on November 3, the candidates you select will be charged with enacting and administering a host of significant laws and regulations governing the use of natural resources. Here's what our elected representatives will face:

1) The Endangered Species Act is due to be reauthorized. To date, it has served as one of the most powerful weapons in the environmentalist's armory. But some argue that it is too powerful, and places too high a priority on obscure species at the expense of economic growth.

2) The Clean Water Act is the major piece of legislation that protects this country's wetlands. It too is up for reauthorization.

3) The archaic 1872 Mining Law needs updating, a process that has been underway for more than 25 years and now appears to be reaching a climax.

4) Marine fisheries are in bad shape. The Magnuson Fishery Conservation and Management Act has not worked well, with the result that 64 out of 101 marine species for which information is available are overfished. With the Magnuson Act up for reauthorization in 1993, will Congress put conservation into fisheries management?

The levers you pull on November 3 will affect these and other important natural resource questions. We want you to know the candidates' positions on these issues.

The 1992 Environmental Elections

Is the environment an election issue? You bet. In the Times Mirror Magazines National Environmental Forum Survey conducted by The Roper Organization and reported in the July issues of all the Times Mirror Magazines, we found that 22 percent of likely voters among the general public have in the past selected a candidate on the basis of his or her environmental positions. But among the likely voters who read this or one of our 11 other magazines, 34 percent have used the environment as a litmus test. Readers of our magazines are thus more willing than the general public to carry their environmental beliefs into the voting booth.

The Information You Need

We asked each Presidential candidate about his proposals to solve natural resource problems. And we asked the Vice Presidential candidates to describe their view of the relationship between economic progress and environmental protection.

A party's platform is its contract with the people. Therefore, we have included excerpts from each platform that pertain to the environment. If you tend to vote along party lines when you are unfamiliar with the actual views of the candidates, the platform provides some insight as to party differences from an environmental perspective.

We sent questionnaires to each candidate in the 34 Senate and 11 gubernatorial races and to candidates in selected House races whose outcomes can have a significant impact on House committees involved with natural resource issues. The responses to the questionnaire are presented in a series of charts. At the bottom row of the chart is our score for each respondent.



The score is based on how the candidate's answers compared to editorial positions taken by the Times Mirror Magazines Conservation Council. Based on our Survey, each of our positions is supported by a majority of Americans and the readers of our magazines.

These, in brief, are the positions on natural resources which the Conservation Council has set forth in previous issues of Times Mirror's magazines:

- Economic development and environmental protection can go forward together, but if harsh conditions make a choice necessary, we lean toward environmental protection.
- Conservation (the wise management and use of natural resources) rather than preservation (an absolute restriction of human activity) should be the guiding precept of natural resource management.
- Further efforts are needed to reduce air and water pollution, and to protect wild and natural areas, endangered species and wetlands.
- Federal government spending should be shifted to environmental programs from other programs such as defense.
- A strong wetlands protection mechanism must be retained in the 1990 Farm Bill and include significant funding for the Wetlands Reserve Program.
- The Clean Water Act's Section 404 pertaining to wetlands protection should be strengthened, and the wetlands permitting process should be freed of bureaucratic complications.
- Funding should be increased for the acquisition of easements from willing private sellers to enhance access to public lands.
- The 1872 Mining Law should be reformed to maintain a strong mining industry while eliminating the give-away of public resources and requiring environmental restoration of mined sites.
- Prioritization of endangered species for protection should be done by scientists with the costs of protection considered.
- Commercial fishermen should pay for what they take, with the funds used to restore marine fishery resources.
- The Forest Service budget emphasis should be partially shifted from timber production to fish and wildlife enhancement.

Not all candidates responded to our questionnaire. In some cases, we found a correlation between a candidate's non-response and a lack of concern for natural resource conservation. We appreciate the cooperation of those who are willing to go public with their positions.

Why Do We Care?

You undoubtedly buy this magazine for reasons other than its political advocacy. Nevertheless, you and the readers of the 11 other Times Mirror magazines enjoy a lifestyle that depends on a healthy, unpolluted environment and the wise management of natural resources. And the choice of the next occupants of the White House and Congress will profoundly affect the quality of the environment. Therefore, I ask that you take the time to familiarize yourself with the environmental positions of the candidates. And most important, go to the polls on November 3 and make your opinion known. It's in your hands.

Francis P. Pandolfi

Francis P. Pandolfi
President and CEO
Times Mirror Magazines

HOW AMERICAN PUBLIC ANSWERS KEY QUESTIONS FACING NEXT CONGRESS AND ADMINISTRATION

Who should prioritize endangered species for protection?



More efforts needed to protect wetlands?



Should hardrock miners on public lands pay a fee for what they take?

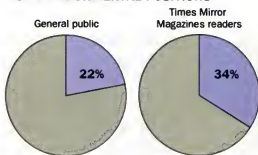


Limit commercial fishing to restore marine fish stocks?



Source: The Times Mirror Magazines National Environmental Forum Survey conducted by The Roper Organization, 1992. Numbers do not add to 100% due to omission of "don't know" and other choices.

PERCENT OF LIKELY VOTERS WHO HAVE SELECTED A CANDIDATE BASED ON ENVIRONMENTAL POSITIONS



Source: The Times Mirror Magazines National Environmental Forum Survey.



GEORGE BUSH

*Answers Questions From
Times Mirror Magazines' Readers*



What do you consider your greatest accomplishments in natural resource conservation?

My administration has achieved historic progress in the area of natural resource conservation. I proposed, negotiated and signed the Clean Air Act Amendments of 1990, the most protective and market-oriented clean air laws in the world; established a moratorium on offshore oil and natural gas drilling; accelerated the United States phaseout of ozone-harming substances; added more fines and penalties and secured more prison sentences for environmental crimes in the last three years than in the previous 20 years combined.

If elected, by 1996 what will you have accomplished toward the conservation of natural resources?

By 1996, my administration will have reduced air pollution emissions by 56 billion pounds—roughly 224 pounds of pollutant for every man, woman and child in America. We will have achieved the goal of reforesting the United States by planting at least four billion trees; have implemented my comprehensive three-part plan to conserve wetlands; boosted recycling, energy efficiency and waste reduction efforts; and, through the research we are undertaking today, drastically reduce the potential for global climate change.

What do you believe is the relationship between environmental protection and economic development? When it comes down to choosing between jobs and the environment, where do you stand?

I believe environmental protection and economic protection, far from being contradictory goals, are inextricably linked. Since 1973, our Gross Domestic Product has grown by more than 50 percent—at the same time, air and water quality have substantially improved. My administration will continue to pursue strong environmental policies while resisting radical approaches that would cause dramatic job loss with no provable or comparable environmental gain.

Do you support the reauthorization of the Endangered Species Act? If so, what amendments should be made?

None of us wishes to contribute to the extinction of a species. But Americans have also built a strong and dynamic economy based on the use of our vast and bountiful resources. We must allow our economy to grow and expand in an environmentally sensitive manner, without facing constant crisis and stalemate. I support the approach of groups like the

Nature Conservancy, which bring together opposing interests to find ways to balance the needs of humans and nature.

Do you believe the 1872 Mining Law needs updating? If so, what amendments do you recommend?

The mining industry plays the primary role in mineral exploration in America. Nevertheless, there are some areas that should be updated. One is to switch to the collection of a holding fee of \$100 annually per claim instead of the \$100 worth of annual assessment work required under current law. Also, we need to more adequately assure a fair return to the Federal Government for the use of surface lands during mining and in compensation for patents. Finally, we should exclude common construction materials such as stone, sand and gravel from the provisions of the Act.

In the upcoming reauthorization of the Clean Water Act, what changes do you think should be made to Section 404 for the purpose of improving wetlands conservation?

I favor inclusion of these elements in the reauthorization of Section 404 of the Clean Water Act:

- strengthen wetlands acquisition and research programs and involve government and the private sector in an effort to restore and create wetlands;
- ensure all Federal agencies observe a common, workable definition of wetlands; and
- improve and streamline the current wetlands regulatory systems so as not to impose burdens on property owners.

In addition, we need some provision to minimize or eliminate the "taking" of property rights in the regulatory process. My Administration will continue to work to enhance public understanding of the value of wetlands.

Under your budget for domestic discretionary spending, would you increase or decrease the amount spent on natural resource conservation? Please name at least five programs for which you would increase or decrease funding.

My 1993 budget includes a \$3.2 billion, or 21 percent, increase in domestic discretionary spending to protect and enhance America's natural resources and environment. They include: expanding America's national treasury of parks, forests, wildlife refuges, and other public lands; fully

(continued)



BILL CLINTON

*Answers Questions From
Times Mirror Magazines' Readers*



What do you consider your greatest accomplishments in natural resource conservation?

One of my greatest accomplishments is preserving Arkansas' outstanding natural heritage. Arkansas offers some of the best fishing streams and lakes in the country; world-record brown trout were taken from the White and Little Red Rivers. Arkansas' forests are home to large populations of deer, turkey and black bear.

I've fought to preserve Arkansas' wild lands and its reputation as the "Natural State." I've focused Arkansas' environmental funding on fish and wildlife programs. Since 1983, we've created nearly 40 new wildlife preserves and parks to protect our rivers, forests, wetlands, and prairies. I've implemented a "no net loss" program for forest land and established the Arkansas Natural and Cultural Resources Trust Fund to protect natural areas and improve state park lands. In addition, my administration created the Arkansas Land Bank and the Arkansas Natural and Scenic Rivers Commission.

I've also cracked down on polluters by beefing up anti-pollution laws and by strengthening enforcement of these laws.

If elected, by 1996 what will you have accomplished toward the conservation of natural resources?

Al Gore and I will fight to protect and conserve America's natural resources. To begin with, I will call upon all Americans to join me in a New Covenant for Environmental Progress, to protect and conserve our natural resources for our children. We will challenge every person, family, corporation, community and government agency to do more to protect our natural resources.

Specifically, I will acquire new parklands and recreation areas with funds now available in the federal Land and Water Conservation Fund to increase opportunities for hunting, fishing and other outdoor activities. And I will direct the federal agencies responsible for natural resources to adopt a true conservation ethic. I will also support a civilian conservation corps to raise environmental awareness among America's young people, to put young people to work on constructive projects, and to protect our natural resources.

What do you believe is the relationship between environmental protection and economic development? When it comes down to choosing between jobs and the environment, where do you stand?

You don't have to sacrifice environmental protection to get economic growth. The choice between jobs and environment

is a false one: we can have both. The administration believes we have to sacrifice the environment in favor of the economy.

In Arkansas, a clean environment means a strong economy. Last year, 16 million people visited Arkansas to take advantage of the abundant opportunities for outdoor sports and recreation. These visitors created thousands of jobs.

From a broader perspective, the market for goods and services related to the environment is approximately \$300 billion and growing at more than seven percent annually. We can create jobs by winning the competition for these rapidly expanding new markets. We must recognize the opportunities to promote environmentally sound economic growth.

Do you support the reauthorization of the Endangered Species Act? If so, what amendments should be made?

Yes, I support the reauthorization. I believe listing decisions for species under the Endangered Species Act should be based on science, not politics.

Do you believe the 1872 Mining Law needs updating? If so, what amendments do you recommend?

No Response.

In the upcoming reauthorization of the Clean Water Act, what changes do you think should be made to Section 404 for the purpose of improving wetlands conservation?

America's wetlands are one of our most treasured natural resources. Wetlands are critical spawning grounds and homes for both fish and other game. I strongly support "no net loss" of our wetlands and I strongly condemn the Bush administration's efforts to rewrite the definition of wetlands, a move which would lead to the destruction of large tracts of wetlands. I would work with scientific experts at the National Academy of Sciences to devise appropriate policies to protect our wetlands.

Under your budget for domestic discretionary spending, would you increase or decrease the amount spent on natural resource conservation? Please name at least five programs for which you would increase or decrease funding.

I would increase funding for several programs. I would add funds to support a civilian conservation corps, improve wildlife and fisheries management, develop renewable energy sources, and reinvigorate the Land and Water Conservation

(continued)



BUSH

implementing my strategy to protect our Nation's wetlands; expanding research into the causes of global change; supporting the development of more energy efficient technologies; accelerating the cleanup of Superfund hazardous waste sites; reducing contamination in specific geographic areas such as the Great Lakes; and increasing Government purchases of alternative fueled vehicles by about 5,000.

A recent report on the status of marine fisheries shows that a majority of these stocks are overfished. How do you plan to implement the recovery of these fisheries?

My 1993 budget provides a total of \$219 million to strengthen the Federal role in fisheries management and conservation. These efforts include: rebuilding U.S. fisheries by reducing overfishing, stabilizing currently productive fisheries, and improving stock assessment; promoting recovery of endangered or threatened species, including marine mammals and sea turtles, by integrating conservation of species and fisheries management; protecting and restoring coastal and estuarine fishery habitats; and improving seafood safety.

What programs will you implement to improve the infrastructure for recreation on public lands?

My America the Beautiful program focuses federal funding and expertise on key recreation areas in need of improvement. With a proposed 21 percent increase over last year's budget, this program will hire 1,000 more seasonal rangers to enhance visitor assistance and resources protection in our national parks during peak use. Revenues from a new 12 month America the Beautiful Passport, sold to the public for \$30, will be used to increase the number of boat ramps, campsites, trails and interpretive centers for America's growing number of outdoor enthusiasts and improve access for disabled Americans to public lands.

REPUBLICAN PLATFORM HIGHLIGHTS

- Support Conservation Reserve Program and other voluntary programs for conservation on farmlands.
- Believe land that is not truly wet should not be classified as a wetlands.
- Will require Congress to affirm priority of an endangered species prior to undertaking specific recovery measures.
- Oil and gas development should be allowed in the Arctic National Wildlife Refuge.
- Will require federal agencies to promptly compensate from their budgets for denial of use of private property for environmental purposes.
- Want to reduce the amount of land owned or controlled by the government.

CLINTON

Fund to make more funds available for the acquisition of public outdoor open spaces. I would decrease funds for building logging roads on public lands.

A recent report on the status of marine fisheries shows that a majority of these stocks are overfished. How do you plan to implement the recovery of these fisheries?

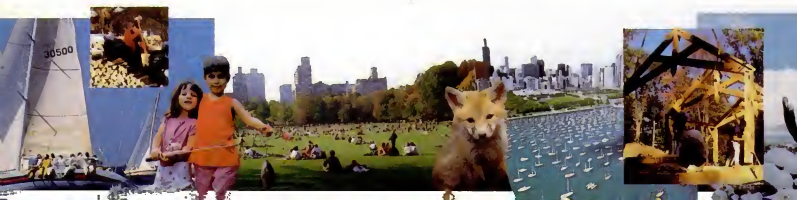
America has the richest fishing grounds in the world. We must preserve and expand this critical renewable resource for both sport and commercial fishing. We need to improve the scientific and technical capabilities of the Regional Fishery Management Councils to make sure that they have the resources and technical wherewithal to develop scientifically sound management plans for our important commercial and recreational stocks. During the past 12 years, the administration has tried to slash funding for fisheries management. I will work with Congress to make sure that our marine and fresh water fishery programs and assistance to states are properly funded.

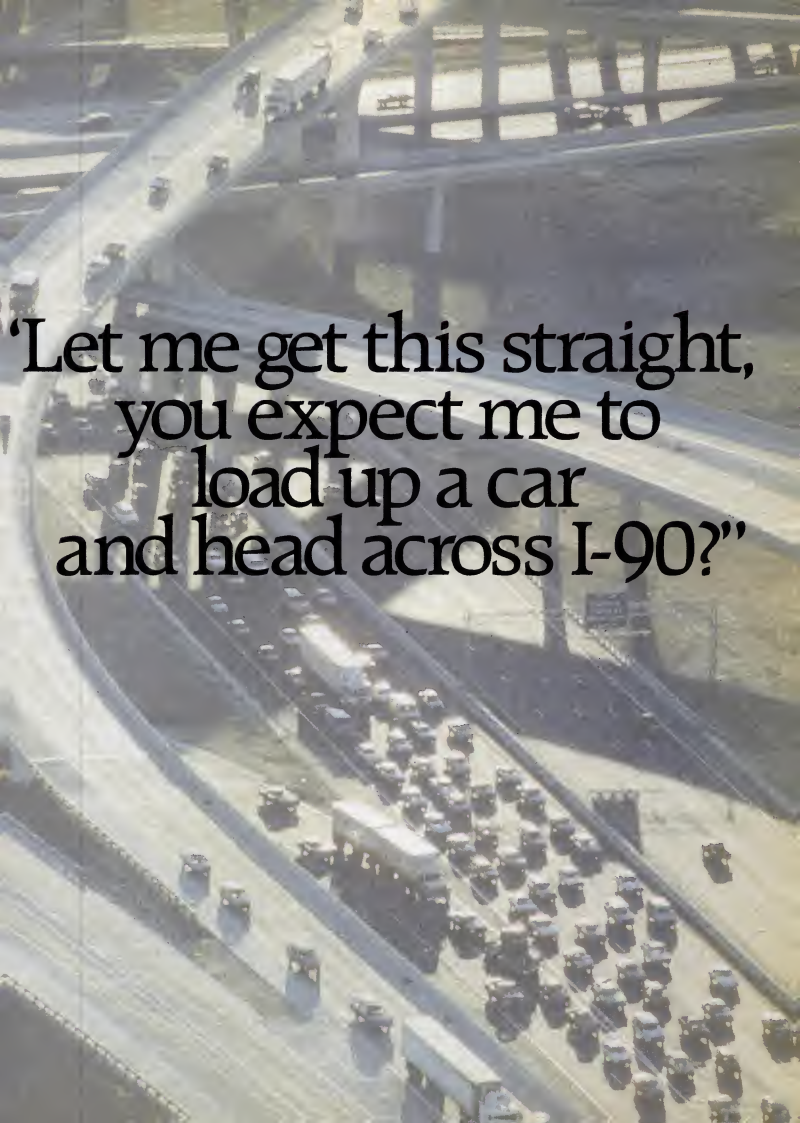
What programs will you implement to improve the infrastructure for recreation on public lands?

Our public lands are some of America's greatest natural assets. Because of misplaced priorities on the part of the administration, America's public land managers face a huge backlog of maintenance and repair—trails have eroded and camping facilities, picnic areas, and boat ramps have fallen into disrepair. I support a new civilian conservation corps, as a low-cost way to restore infrastructure on public lands, while inspiring civic pride and responsibility. I would also make funds available from the Land and Water Conservation Fund to help address critical infrastructure needs in state and local facilities. Finally, I would work to ensure appropriate access to public lands.

DEMOCRATIC PLATFORM HIGHLIGHTS

- Will work to protect old growth forests, provide a genuine "no net loss" policy on wetlands and preserve critical habitats.
- Oppose Republican efforts to gut the Clean Air Act under the guise of competitiveness.
- Will create a civilian conservation corps for American youth.
- Oppose new offshore oil drilling and mineral exploration of environmentally critical areas.
- Would join European allies in agreeing to limit carbon dioxide emissions to 1990 levels by the year 2000.
- Believe population growth must be controlled by working with other nations and organizations to fund greater family planning efforts.



An aerial photograph of a complex multi-level highway interchange. The image shows several overpasses and ramps with heavy traffic. Numerous cars and large trucks are visible, particularly on the lower levels of the interchange. The scene is captured from a high angle, showing the intricate layout of the road infrastructure.

**'Let me get this straight,
you expect me to
load up a car
and head across I-90?'**

A white station wagon is shown from a rear three-quarter view, parked on a grassy field. The car has a spare tire mounted on the back and a dark lower body cladding. In the background, there are dark, silhouetted trees and a range of mountains under a cloudy sky. The overall tone is somewhat muted and atmospheric.

**“Where
sense of a**



Is your adventure?"

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Buckle up, America!



THE STRENGTH OF EXPERIENCE

KEY STATE RACES

RANKING THE CANDIDATES

The candidates in all 34 Senate races and 11 gubernatorial races were surveyed. In addition, candidates from select House races were included because the incumbent is in a leadership role on a committee or subcommittee that decides natural resource issues. In some states, more candidates are listed than are actually running because some candidates lost in a primary after this Guide went to press.

Each campaign office received at least three phone calls to verify that the questionnaire had been received. Where necessary, an additional copy was sent.

The questions are framed in an either/or manner. Many candidates provided additional comments in response to the questions. On the scoresheet, an ✱ is shown where the candidate checked the indicated response. A ● is shown where a written-in response is closest to this choice.

Conservation Council Score: A candidate's score is based on how responses to 14 of the 28 questions we asked compared with editorial positions taken by the Times Mirror Magazines Conservation Council. These positions are stated in the introduction to this Guide. You may wish to adjust the score if you disagree with our positions.

Each question is worth one-fourth of the total score. A pro-conservation response receives the full value of the question. Non-responses are assigned a quarter of the value of the question to give a candidate some benefit of the doubt. Where candidates wrote comments suggesting a balance between the choices, they receive half the value of the question. If the written comments lean more toward conservation, three-quarters of the value of the question is assigned. An "anti-conservation" response to a question is given a zero. A score of 100 represents total agreement with our positions.

Some candidates did not respond to the entire questionnaire. Their column is left blank and a 'NR' is shown for their score. For gubernatorial races, those questions that are not relevant to the state are excluded and a 'NA' is shown.

The states of Alabama, Georgia, Indiana, Louisiana and Nevada did not have sufficient responses to merit inclusion. The Senate or gubernatorial race has been omitted in several states because neither candidate responded.

On this scoresheet, the candidates go on record with their specific environmental positions. Make sure they keep their promises once they're elected. Save this scoresheet to compare it with their records in the future.

QUESTION/ISSUE

- 1 Can environmental protection and economic development go hand in hand?
☐ Can go hand in hand
☐ Must choose between environment and development
- 2 Which is more important: economic development or environmental protection?
☐ Economic development
☐ Environmental protection
- 3 Which statement most closely describes your view on natural resource management?
☐ The best way to preserve wildlife, natural areas, and natural resources is to prevent development and restrict most other human activity in these areas
☐ We can protect and conserve wildlife, natural areas, and natural resources by managing these resources, while also using them for the benefit of our economy and the public
- 4 Federal spending should be shifted to environmental programs from defense.
☐ Agree
☐ Disagree
- 5 Will you vote to increase the budgets of the BLM and the Forest Service to acquire easements across private land from willing sellers to access public land?
☐ Yes
☐ No
- 6 Which elements of the reform of the 1872 Mining Law do you favor?
☐ Royalty payments for extracted minerals
☐ Elimination of the patenting provision
☐ Elimination of the "right to mine"
☐ The present law is fine
☐ Mining shouldn't be allowed at all on public land
- 7 Would you support shifts in the Forest Service budget from road building for logging to public recreation opportunities and restoration of fish and wildlife?
☐ Yes
☐ No
- 8 Should we maintain strict policies on the protection of wetlands that could hurt our chances for economic growth and jobs?
☐ Yes, sacrifice is worth making
☐ No, sacrifice is not worth making
- 9 Will you support a strong Swampbuster provision of the 1990 Farm Bill to eliminate subsidies to farmers who drain or fill wetlands on their property?
☐ Yes
☐ No
- 10 Do you support the Wetlands Reserve Program where farmers are paid to permanently protect wetlands on their property?
☐ Yes
☐ No
- 11 Should we maintain strict policies on the protection of endangered species that could hurt our chances for economic growth and jobs?
☐ Yes, sacrifice is worth making
☐ No, sacrifice is not worth making
- 12 Who should decide which endangered plants and animals should be given priority protection?
☐ Government/Politicians
☐ University Biologists or Environmentalists
- 13 Do you support halting commercial fishing for certain salt water fish where the economic benefit of its use in a recreational fishery exceeds that in a commercial use?
☐ Yes
☐ No
- 14 Will you support repealing the gas tax exemption for commercial fishermen if the funds are targeted to the restoration of the fish stocks that they use?
☐ Yes
☐ No

T Times Mirror Magazines Conservation Council Score

	AK		AZ		AR		CA		CO		CT		DE		FL		HI		ID		IL		IA	
	SEN	CON	SEN		SEN		SEN	SEN	SEN		SEN		GOV		SEN	CON	SEN		SEN		SEN	CON	SEN	CON
41	Frank Murkowski—R		John McCain—R		Dale Bumpers—D		Dianne Feinstein—D		Ben N. Campbell—D		Chris Dodd—D		Tom Carper—D		Bob Graham—D		Daniel Inouye—D		Richard Stallings—D		Carol Moseley-Braun—D		Charles Grassley—R	
64	Tony Smith—D		Claire Sargent—D		Mike Huckabee—R		Bruce Herschensohn—R		Terry Considine—R		Brook Johnson—R		B. Gary Scott—R		Bill Grant—R		Rick Reed—R		Dirk Kempthorne—R		Rich Williamson—R		Jean Lloyd-Jones—D	
41	Don Young—R						Barbara Boxer—D				Chris Burnham—R				Earl Hutto—D						Sidney Yates—D		Neal Smith—D	
79	John Devenney—D						John Seymour—R				Chris Burnham—R				Terry Ketchel—R						Herb Sohn—R		Paul Lunde—R	
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QUESTION/ISSUE

- ☐ Can go hand in hand
- ☐ Must choose between

- ☐ Economic development
☐ Environmental protection

- ☐ Preservation
☐ Conservation

- ☐
- Agree
-
- ☐
- Disagree

- ☐ Yes
☐ No

- ☐ Royalty payments for extracted minerals
- ☐ Elimination of the patenting provision
- ☐ Elimination of the "right to mine"
- ☐ The present law is fine
- ☐ Mining shouldn't be allowed at all on public land

- ☐ Yes
☐ No

- ☐ Yes, sacrifice is worth making
- ☐ No, sacrifice is not worth making

- ☐ Yes
☐ No

- ☐ Yes
☐ No

- ☐ Yes, sacrifice is worth making
☐ No, sacrifice is not worth making

- ☐ Government/Politicians
☐ University Biologists or Environmentalists

- ☐ Yes
☐ No

- ☐ Yes
☐ No

- T Times Mirror Magazines Conservation Council Score**

	MN		MS		MO		MT		NE		NH		NJ			NM		NY		NC	
	CON	CON	CON	CON	SEN	GOV	CON	CON	CON	SEN	GOV	CON	CON	CON	CON	CON	SEN		GOV		
	Bruce Vento—D				Kit Bond—R				Bill Barrett—R		John Rauh—D		William Hughes—D				Robert Abrams—D		James Hunt—D		
	Ian Maitland—R				Geri Rothman-Serot—D			Lowell Fisher—D		Larry Brady—I		Frank LoBiondo—R		Joseph Skeen—R			Alfonse D'Amato—R		Jim Gardner—R		
	Jim Oberstar—D				Bill Webster—R					Judd Gregg—R		Joe Kyriillos—R		Dan Sosa—D			Geraldine Ferraro—D				
	Phillip Herwig—R				Mel Carnahan—D					Steven Merrill—R		Jim Saxton—R		Timothy Ryan—D			Elizabeth Holtzman—D				
										Deborah Amescen—D											

KEY STATE RACES

QUESTION/ISSUE

- Environmental protection and economic development?**
☐ Can go hand in hand
☐ Must choose between
- Which do you usually believe is more important?**
☐ Economic development
☐ Environmental protection
- Best natural resource management?**
☐ Preservation
☐ Conservation
- Shift federal government spending to environment?**
☐ Agree
☐ Disagree
- Increase budgets for public lands access?**
☐ Yes
☐ No
- Favor 1872 Mining Law reform?**
☐ Royalty payments for extracted minerals
☐ Elimination of the patenting provision
☐ Elimination of the "right to mine"
☐ The present law is fine
☐ Mining shouldn't be allowed at all on public land
- Forest Service budget shift to recreation/fish and wildlife?**
☐ Yes
☐ No
- Maintain strict wetlands protection?**
☐ Yes, sacrifice is worth making
☐ No, sacrifice is not worth making
- Support strong swampbuster provision of the 1990 Farm Bill?**
☐ Yes
☐ No
- Support Wetlands Reserve Program?**
☐ Yes
☐ No
- Maintain strict endangered species protection?**
☐ Yes, sacrifice is worth making
☐ No, sacrifice is not worth making
- Who prioritizes endangered species protection?**
☐ Government/Politicians
☐ University Biologists or Environmentalists
- Sport-only salt water fisheries?**
☐ Yes
☐ No
- Repeal gas tax exemption for commercial fishermen?**
☐ Yes
☐ No

T Times Mirror Magazines Conservation Council Score

	ND SEN	OH SEN	CON	OK CON	OR SEN	PA CON	RI GOV	SC SEN
	Byron Dorgan—D Steve Sydness—R	John Glenn—D Mike DeWine—R Mary Rose Oakar—D Martin Hoke—R		Mike Synar—D Drew Edmondson—D Terry Gorman—R Jerry Hill—R	Les AuCoin—D Bob Packwood—R	Peter Kostmayer—D James Greenwood—R	Michael Levesque—R Bruce Sundlun—D	Ernest Hollings—D Tommy Hartnett—R
1	XX	X	X	X	X	X	XX	X
2		X	X	X	X			X
3	XX	X	X	X	X		XX	X
4	XX	X	X	X	X	X	X	X
5	X	X	X	X	X	X	N A	X
6	X	X	X	X	X	X	N A	X
7	XX	X	X	X	X	X	N A	X
8		X	X	X		X	XX	X
9		X	X	X	X	X	XX	X
10	XX	X	X	X	X	X		X
11	X	X	X	X		X	X	X
12	X	X	X	X	X	X	XX	X
13	X	X	X	X	X	X	XX	X
14	X	X	X	X	X	X	X	X
T	48	79	NR	89	84	84	59	NR

	SD	TN	TX	UT	VT	VA	WA	WV	WI	WY
	SEN CON	CON	CON CON	SEN GOV	SEN GOV	CON	SEN GOV	CON	SEN CON	CON
	Tom Daschle—D Charlene Haar—R	Jimmy Duncan—D Troy Goodale—R Bob Clement—D Tom Stone—R	Jack Fields—R Charles Robinson—D Kika de la Garza—D Tom Haughey—R	Robert Bennett—R Wayne Owens—D Stewart Hanson—D Mike Leavitt—R	James Douglas—R Pat Leahy—D Howard Dean—D John McClaughry—R	Leslie Byrne—D Henry Butler—R	Don Bonker—D Rod Chandler—R Tim Hill—R Patty Murray—D Leo Thorpe—R Ken Eikenberry—R Joe King—D Mike Lowry—D Sid Morrison—R	Nick Joe Rahall—D Ben Waldman—R	Russ Feingold—D Robert Kasten—R Thomas Petri—R Peg Lautenschlager—D	Craig Thomas—R Jonathan Herschler—D
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3	X X	X X		X X	X X	X	X X	X	X X	X X
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7	X X	X X	X X	X X	X X	X	X X	X X	X X	X X
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9	X X	X X	X X	X X	X X	X	X X	X X	X X	X X
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8	X X	X X	X X	X X	X X	X	X X	X X	X X	X X
9	X X	X X	X X	X X	X X	X	X X	X X	X X	X X
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2	X X	X X	X X	X X	X X	X	X X	X X	X X	X X
3	X X	X X	X X	X X	X X	X	X X	X X	X X	X X</

THE VICE PRESIDENTIAL CANDIDATES



"What is the relationship between domestic economic progress and the protection of this nation's natural resources? Can economic progress and environmental protection co-exist or should we favor one over the other?"

DAN QUAYLE

This fall, President Bush and I will rally the American people behind an agenda for building a stronger, safer, more secure America. On the issues—taxes, government spending, family values, strong defense, and combining environmental protection with strong economic growth that creates jobs—Americans will choose between two fundamentally different views of the future.

President Bush's environmental program is working. Under his new Clean Air Act, the cities not in compliance with clean air standards were cut by 40 percent. Toxic emissions are being cut to reduce the health risks to Americans by 75 percent. America's rivers and waterways are cleaner than ever.

As Chairman of the President's Council on Competitiveness, I have worked to implement promptly environmental programs that also promote economic growth and job creation. In two years, we have already proposed clean air regulations that will achieve 75 percent of the reductions in air pollution. These regulations are drafted to save America's small businesses from bureaucratic red tape and reduce the cost by \$2 billion. In short, we put people first while protecting the environment.

By contrast, under Bill Clinton, Arkansas ranks 42nd out of 50 states in environmental protection. To hide his record, Clinton picked Al Gore as his running mate. Together, they peddle policies that put lawyers and unelected bureaucrats in the driver's seat. Gore wants to abolish the internal combustion engine. He supports a carbon tax that will raise gas prices 26 cents and dramatically increase utility bills. They want to increase mileage requirements nearly 50 percent—resulting in unsafe cars, and threatening over two million American jobs.

America has a choice: Clinton/Gore's environmental extremism and job losses. Or the prudent stewardship of President Bush, whose policies will produce economic growth and a cleaner environment.



AL GORE

Voodoo economics is still alive. The current myth—environmental protection is incompatible with economic growth. The truth: sound environmental policies are a precondition of economic growth, not a brake on it. In forcing this false choice, George Bush and Dan Quayle are threatening our economic future, our environment, and the quality of life our children will enjoy.

Protecting the environment means investing in the future and in a growing economy that will produce new jobs and increase productivity. By protecting our natural resources we preserve the foundation for economic progress. Natural systems support the production of goods and services in every sector of the economy. And, environmental efficiency helps businesses become more competitive. After all, pollution really is waste—what's left over from the production of goods. Reducing pollution—economic waste—increases profits and makes our industries more competitive. A recent report from the chemical industry, for example, shows that investments in pollution prevention pay off—firms dramatically cut costs by reducing waste, saving energy and streamlining their operations.

Our competitors have gotten the message and they're taking action. The global market for environmental technologies is currently at about \$270 billion a year and is growing at seven percent a year. Openly proclaiming this to be the biggest opportunity in the history of world business, Germany and Japan are poised to seize the opportunity. Are we?

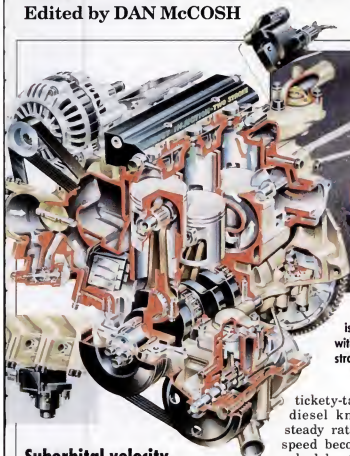
We do indeed have a choice to make—but it is not the false choice presented by George Bush and Dan Quayle between jobs and the environment. The real question is whether we will cling desperately to the tired polluting ways of the past or move forward aggressively to strengthen our economy, create jobs, increase productivity, and ensure a healthy environment for our children. Bill Clinton and I think the choice is clear.

Photo sources: Cntr. for Marine Conservation; Dept. of Tourism (DOT) MT; Bush: American Recreation Coalition Photo; Clinton: Sylvester/PPG; Gore, Quayle: Reuters/Bettmann. Frieze photos L to R: DOT MT; USDA Forest Service (USDAFS); DOT CA; Ski the Summit (SS); DOT FL; DOT TN; Cntr./POPULAR SCIENCE (PS); DOT MT; SS; USDAFS; DOT MT; bald eagle: Scott Wm. Hanrahan; DOT MT; bow hunter & white-tail deer: Scott Wm. Hanrahan; DOT CA; sailboat: Charles Barthold; USDAFS; Vuch/GOLF; DOT FL; DOT Chicago; S. Andresen; Knepp/Mono Lake Comm. Cntr./PS; DOT FL; woodchopper: Hubert Schriebl; Pamela Loren; Central Park: Kanno/PPG. Red fox: Scott Wm. Hanrahan; DOT Chicago; M. Morris; DOT AZ; USDAFS; DOT FL; S. Andresen; USDAFS; SS; DOT MT.



Automotive Newsfront

Edited by DAN McCOSH



Ford of England's Fiesta (right) is disappointingly slow and noisy with the compact Orbital two-stroke engine (left) installed.

Suborbital velocity

"Never mind the noise, feel the power," a Ford of England technician tells European correspondent David Scott before a trial drive in a prototype British Fiesta with an Orbital two-stroke from Australia under the hood. The 1.2-liter two-stroke delivers 80 horsepower, a third more than Ford's comparable displacement four-stroke.

"Its greater muscle is immediately apparent as I jab the accelerator in second gear, when the little car surges forward like a hot hatch," reports Scott.

"The downside is noise. At its low 600-rpm idle the engine has an odd,

tickety-tack rhythm hinting at diesel knock. Under way, the steady rattle fades a bit, and at speed becomes a hushed clatter masked by tire and wind noise. I wouldn't like to live with it, despite the impressive performance."

Two weeks later, a drive in a second prototype, this time at Orbital's unfinished manufacturing plant in Tecumseh, Mich., proves even less encouraging. This Fiesta shakes severely at idle, acceleration is mediocre at best, and overall the car performs worse than an Orbital-powered Ford Escort that POPULAR SCIENCE drove three years ago.

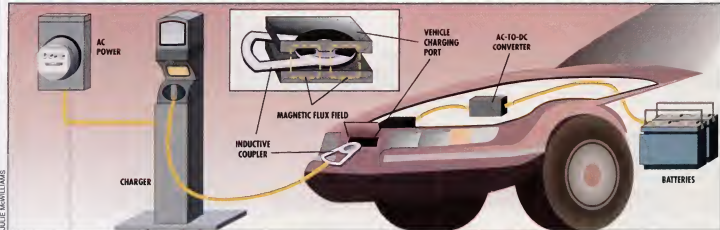
Apparently anxious to demonstrate its lead in the two-stroke race, Ford is evaluating a prototype fleet of about 50 two-stroke Fiestas on British and German roads and promises a produc-

tion model for Europe by 1995. Still, the automaker appears to have done little development work on the chassis or engine so far to address the drivability problems.

Perhaps more significant than the feeble Fiesta is Ford's announcement that it has independently substantiated at least some of Orbital's emissions tests for its two-stroke engine design. So far, however, the engine has only passed current U.S. emissions standards for 50,000 miles. Orbital also says it has passed California's pending standards for Ultralow Emissions Vehicles, but Orbital's numbers indicate that it has only met those standards for hydrocarbons and carbon dioxide, not the critical oxides of nitrogen emissions.

Tooling up for Impact

Hughes Power Control Systems in Torrance, Calif., has set up a production line to produce electric car inverters, the solid-state black boxes that



Hughes Power Control Systems' noncontact inductive "paddles" allow safe recharging for electric cars even with high-amperage current.

BATTLE OF THE BATTERIES

BY RICK COOK

Batteries provided most of the technical interest at this year's Arizona Public Service Solar Electric 500 electric vehicle race—and a battery also ended the race. The three-day competition featured everything from solar-powered vehicles to hybrid gas-electric vehicles constructed by high school students, hobbyists, and small-volume manufacturers.

On the race track—the same as on public roads—the key to a successful electric vehicle is the battery system. The event showed off most of the major battery technologies that might power practical electric cars in the next decade or two. Entries in the electric stock-car race used lead-acid, zinc-air, zinc-bromine, nickel-cadmium and nickel-iron batteries. A vehicle with a sodium-sulfur battery ran demonstration laps and nickel-metal hydride batteries were on display in the exhibit area.

It became apparent early on that the stock-car race would be dominated by the exotic battery technologies. Although some of the lead-acid cars posted good lap times, they simply didn't have enough energy to keep the winning pace. In Saturday's Open race, which was run under different rules, several of the lead-acid cars changed batteries as often as eight times in pit stops.

A zinc-air-powered entry, sponsored by Arizona Public Service Co. and built by Dreisbach Electromotive Inc. (DEMI), was based on a modified Saturn coupe. On each of the three days of the event the car ran a one-lap race against a conventional Saturn used as a reference vehicle. The electric car never won, but by the last day the conventional and electric vehicles finished within half a car length of each other.

A zinc-air battery uses oxygen from the air and zinc in an electrolyte of potassium hydroxide. Less exotic than zinc-air, nickel-iron uses a base electrolyte, usually a potassium hydroxide solution. Nickel-iron



Entries at the Phoenix Solar Electric 500 car race used a broad range of battery technologies.

doesn't have the energy storage capacity of some of the other technologies, but it has nearly twice as much as lead-acid cells. With an energy density of 80 watt-hours per kilogram, the zinc-bromine battery packs about three times as much energy per kilogram as a lead-acid battery. This puts it behind zinc-air and sodium-sulfur in the energy-density sweepstakes, but it operates at room temperature, and doesn't need an auxiliary battery pack for burst power.

The meet's final event came to a sudden and dramatic end when the zinc-bromine battery pack started billowing red-orange smoke on lap 92. A battery fitting had come loose and both dark red bromine vapor and liquid bromine came pouring out of the battery casing in the Solectria Force made by Solectria Corp. of Arlington, Mass. Driver James Worden spun his car out on the edge of the infield, bailed out the window, crawled away from the car, and collapsed. Worden was airlifted to a nearby hospital and spent three days there. Fourteen other people who had breathed the bromine fumes were also taken to the hospital. Race promoters canceled the rest of the race and evacuated the track as a precaution.

Despite Worden's experience, and though none of the alternative batteries emerged from the races as a clear winner, the overall performance of the field demonstrated one fact quite clearly: The auto industry is getting closer and closer to producing a practical electric car suitable for the way the average American drives. Many of the cars in the electric stock event averaged more than 55 mph over the 91 laps of the race with the winner's speed at about 62 mph.



A bromine spill that started with an overheated battery in a Solectria Force sent several people to the hospital and prematurely ended the race.

ROVER RETURNS

convert direct current from the batteries to alternating current for the drive motors, as well as managing other electrical functions such as incoming current from regenerative braking.

Hughes also unveiled a line of prototype electric-car charging equipment, ranging from small portable units to multi-car drive-in "kiosks" for rapid charging at electric-vehicle service centers. Demonstration units will be delivered to test fleet operators next year, Hughes officials say.

All four charger models use an inductive coupling device that connects the charger with the vehicle's charging port. Resembling a big black cookie with a handle on it, the coupler's plastic-coated "paddle" clicks into place when inserted in the port. Hughes claims the device eliminates the hazard of electric shock while hooking up the charger. The noncontact device uses magnetic fields produced by electrical coils embedded in the paddle, which interact with fields produced by coils in the charging port to complete the circuit. Metal-to-metal physical contact, as in a conventional plug, is eliminated.

According to Daniel Rivers, manager of electric vehicles, the electrical losses at the inductive coupling are

The original Land Rover grew out of a desperate need for farm trucks in post-World War II Britain, but it made its reputation in Asia, Africa, the South Pacific, and South America as the one that always got through somehow. Now the Land Rover is back, 20 years after it was last seen on U.S. shores, in the form of the brawny, quasi-military Defender 110. Rover intends to import a mere 500 of these vehicles, at about \$45,000 apiece. The U.S. company will also change its name to Land Rover.

A combination of box-section steel chassis, flat glass, and aluminum body panels, the five-door, nine-passenger rolling antique uses a 180-hp version of the 3.9-liter Rover aluminum V8 that makes 227 pound-feet of torque at 3,250 rpm, qualifying the vehicle as the most powerful Land Rover ever built. It tows 7,700 lbs. off-road, and an 8,000-lb. winch is optional. Viscous differentials make it a full-time four-wheel-drive system with a two-speed transfer case.

The suspension offers 11 inches of travel with 8.5 inches

of ground clearance. Probably its most distinctive feature that sets it off from the suburban mall patrol is an external roll cage that thwarts charging rhinos and allows easy recovery after tumbling down a jungle ravine. We drove it across 5,000 acres of trails at Eastnor Castle in the British midlands, and we're absolutely sure it will handle North America's snow and ice as well.—Jim McCraw



CRAFTSMAN COLLECTOR SERIES

The last wrench set you'll ever need.

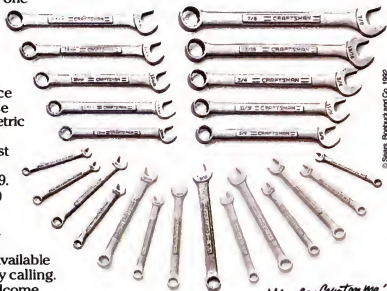
This is your chance to get an incredible assortment of rugged, durable Craftsman® wrenches—wrenches that are made in America and guaranteed forever—for one unbelievably low price. Let's face it. You can never really have enough wrenches. So if you need another set for the car or the garage, this is it. However, if you only buy one wrench set in your life, this is probably the only one you'll ever need.

Standard, Metric, Ignition Sets; all for \$59. You get 34 wrenches in all: a 12-piece standard combination set (1/4" to 7/8"), a 12-piece metric combination set (6mm to 17mm), plus your choice of two 10-piece combination ignition sets. Choose standard (5/32" to 7/16") or metric (4mm to 11mm). Purchased separately, these wrenches cost over \$100. But if you call now, you can get them all for just \$59. (Shipping and handling \$4.95)

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typically less than 1 percent. The coupling technology draws on Hughes' experience in developing shock-proof underwater couplings used by divers working on offshore drilling platforms in Britain's North Sea.

The charging systems are "smart" in that they can query the car's batteries to determine how much charge they can accept and how fast. They will also be able to keep track of whom to bill for the electricity. At home, the cost will show up on the residential electric bill, while drivers topping up batteries at remote charging stations will likely pay with credit cards.

—Stuart F. Brown

New compacts share chassis

Chevrolet's Geo division and Toyota have produced one of the most successful hyphenated car projects this model year—the redesigned Corolla and Geo Prizm, sharing mechanicals, but not interiors or exterior sheet metal.

On the outside, Toyota has given the 1993 Corolla rounded corners quite similar to the Tercel and Camry. On the inside, Toyota stretched the cab, adding three inches of total legroom (and 5.5 more cubic feet of space)—moving the Corolla from subcompact to compact class. Geo's Prizm is dimensionally similar, but with a one-piece side panel and a more streamlined instrument panel. Weight and gas mileage (28 mpg in the city/33 to 34 mpg on the highway) are about the same as the old model. For the first time, a driver-side air bag comes standard with all models; ABS is optional.

Under the hood, the Deluxe and top-of-the-line LE models come with a new 1.8-liter, 16-valve engine, which provides 115 horsepower (same as the



P R E V I E W D R I V E

HYUNDAI'S OWN MOTOR



The cars that Korean automaker Hyundai has sent to the United States to date have been powered by Mitsubishi-designed engines. For 1993, the Scoupe sporty coupe comes with a 1.5-liter homegrown engine that develops 92 horsepower in its naturally aspirated version, and 115 hp with the addition of a small turbocharger.

An engineering team at the company's Mabooki Engineering Research and Development Center near Seoul worked for six years designing the compact four-cylinder motor. The relatively long-stroke engine uses three valves per cylinder actuated by a single overhead camshaft.

In its turbo version, the little engine scoots the Scoupe around adequately without excessive lag waiting for the boost to come on. But for a turbo motor, power output is disappointing—and not much greater than the best 16-valve non-turbo engines. Clearly, Hyundai has tuned its budget hot rod for longevity. Scoupe turbos will sell for under \$11,000, while models with the new 92-hp engine keep the \$9,000 1992 price tag.

Hyundai's base model Elantra sedan with automatic transmission and upscale GLS models will have a 1.8-liter 16-valve motor that produces 124 hp. The dual-balance-shaft Mitsubishi-designed engine is a smooth runner that develops 116 pound-feet of torque. The five-speed Elantra base model retains its smaller 113-hp original motor.—S. F. B.

last Camry). The base model still has a 1.6-liter power plant.

Driving in the Adirondack mountains, the 1.6-liter, five-speed manual and 1.8-liter four-speed automatic proved roughly equivalent: Both accelerated and shifted smoothly across a broad range of speeds. (The 1.8 liter also comes in a five-speed manual.) On the relatively smooth test roads, at least, the suspension was firm but not harsh. The new Corolla/Prizms are markedly improved over the wind-sway-prone older models. Front seats are firm and comfortable, if somewhat narrow. The most notable improvement is the noise level: New braces and foam rubber insulation mute engine vibrations, making the new Corolla far quieter than previous editions.

Toyota hopes to market this car to people who want something more than a subcompact, but find the new Camry

out of their price range. In fact, a typically equipped Deluxe Corolla should sell for around \$12,000 to 14,000—about what Camrys cost a couple of years ago.—Robert Langreth

Running flat

A complete high-performance run-flat tire system, recently unveiled by Bridgestone, includes a specially constructed bead-retention aluminum alloy wheel made in Japan for Bridgestone and a low-pressure warning device. The run-flat system is based on a variant of the Bridgestone Expedia S-01 high-speed tire in one size only—P275/40ZR-17. Bridgestone says the tire/wheel combination is capable of traveling at least 50 miles at 55 mph with zero air pressure, and can be repaired using conventional radial tire plugs.

The system will be available at first only for 1988 to '93 Chevrolet Corvettes and Callaway Corvettes, the ultra-high-performance variants built

Geo Prizm (top left) differs from its Toyota Corolla sibling in exterior and interior styling, but shares mechanicals.

by Callaway Cars in Old Lyme, Conn. Callaway will be the exclusive U.S. distributor for the Bridgestone run-flat system.

The Expedia S-01 Runflat A/M, as it is called, uses a specific rubber compound plus a low-pressure support insert that together allow the deflated tire to support the weight of the car for extended driving. Bridgestone claims that the tire/wheel design also enhances vehicle control in blowout situations. The unidirectional aluminum wheel has a "wedge hump" rim that is designed to keep the tire attached to the bead under zero-pressure conditions.

The third element of the system, the tire-pressure warning device, consists of transmitter modules for each of the four wheels, a radio receiver, and a warning indicator intended for dashboard mounting, manufactured by Epic Technologies of Norwalk, Ohio. The modules sense and then broadcast the news of a pressure drop in any tire to the warning device,



Bridgestone's run-flat tire uses a locking rim and self-supporting rib.

which informs the driver that the run-flat system is operating, even though the driver may not feel the pressure loss.

The run-flat system as installed by Callaway will cost about \$5,000 for four tires, four wheels, and the sensor/warning system. Bridgestone says it is working with auto manufacturers to offer a low-cost run-flat system that will eliminate the need for heavy, bulky spare tires, offering the manufacturers opportunities to save weight and gain trunk space.—J. M.

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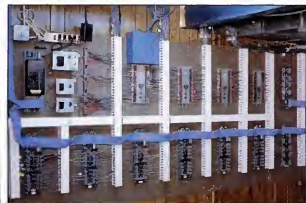
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Home Newsfront

Edited by MARIETTE DiCHRISTINA



In a test house (top left), "people" are actually occupant simulators (above right) that produce heat and humidity. Measurements are compiled via the data-acquisition system board (above left).



GAS RESEARCH INSTITUTE

All in the (artificial) family

Imagine a three-bedroom brick house where the "people" are actually black cylinders with light bulbs as hearts. Welcome to the Gas Research Institute's test house, in a real Chicago neighborhood. Here, nearly every human activity involving air movement, temperature, and humidity is simulated for a family of four.

Operated by the Chicago-based institute, which researches and develops new natural-gas technologies, the test house is helping engineers, architects, and builders learn more energy-efficient ways of maintaining indoor comfort. The researchers replace people with heat sources (the light bulbs), humidifiers, and sensors to provide a controlled setting. This is because it's difficult to measure space conditioning, unvented combustion, and indoor air quality with a real family that constantly opens and closes the doors.

One of the current test subjects is a heat pump being developed with York International of York, Pa. Instead of using an electric motor to drive the compressor, it has a Briggs & Stratton natural-gas-fueled engine ("What's Next in Home Energy," Nov. '90). Now being test-marketed, the efficient

variable-speed heat pump is expected to be widely available in about a year, say York officials.

Neil Leslie, manager of the project, says the test house has yielded key findings: For example, ceiling fans allow the air-conditioning system to work at higher temperatures (thus saving energy), and "zoned" heating/cooling for every room (using separate thermostats and electronic dampers) increases comfort.

With nobody really living in the house, who watches it? An array of computer sensors and a security system monitor each room every five seconds. The neighbors don't complain.

—John F. Wasik

Panels for insulation

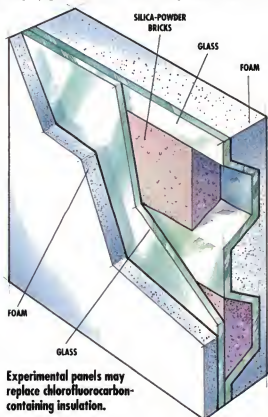
An experimental panel that encapsulates silica powder within vacuum chambers may provide a new insulation option for refrigerators and houses.

Several models of the panels have been designed, using metal or plastic enclosures. But a new panel developed by Leon Glicksman, a professor of ther-

mal science and building technology at the Massachusetts Institute of Technology in Cambridge, uses a glass closure instead. Glicksman says that the glass will prove to be superior because its heat conductivity, or ability to transfer heat, is only about 5 percent that of metal, and its durability is greater than that of plastic. These features will enable the panel to maintain its vacuum for a minimum of 20 years.

The basic panel construction calls for a sheet of glass, $\frac{1}{100}$ inch thick, impressed with three- to five-inch-wide indentations for radiative-heat-blocking silica-powder bricks. A second sheet of glass seals the silica into a vacuum chamber, with a quarter-inch layer of non-chlorofluorocarbon-containing foam serving as a protective cushion. (Chlorofluorocarbons, or CFCs, are found in some insulative foams; the chemicals are being phased out of use.) The thinness of the glass decreases the panel's heat conductivity, making the system a better insulator. The thin glass also provides tremendous flexibility, allowing the panel to withstand the stress of dramatic temperature changes.

Manufacture of the panels is not expected to be costly because silica and glass are relatively inexpensive.



Experimental panels may replace chlorofluorocarbon-containing insulation.

JANA BERNARD

CONSTRUCTION-WASTE DISPOSAL: IT'S A GRIND



LINCOLN JOURNAL-STAFF PHOTOGRAPHY CO.

Top grinders (above) can reduce construction waste down to one-sixth of its original volume, saving space in often-overcrowded landfills.

With municipalities increasingly running out of available waste-disposal space, imagine the trepidation—and the expense—of driving up to the landfill with several truckloads of debris from a demolished house or building.

This predicament has inspired the use of top grinders in demolition. Top grinders aren't new—they've been used for decades to render logging scraps into wood chips. However, their use in grinding down construction debris is now catching on nationwide. Jim Eckley, for example, who operates Aggregate Carriers of Mead, Neb., says that his top grinder can reduce a typical 1,200-square-foot 1½-story home to 130 yards of pulverized debris in two hours (see photo).

The \$300,000 machine that Eckley uses, made by Morbark Inc. of Winn, Mich., has a large hopper that contains an eight-foot disc with 56 whirling carbide-steel blades. A knuckle-boom loader lifts the demolished house into the hopper, where it is ground and blown onto a conveyor. From there, it's off to the landfill.

"The entire house can be hauled off in a single truck," Eckley adds. Ordinarily, the mass of debris from a demolished house would fill six truckloads. "About the only thing that gives us trouble is an inner-spring mattress. The grinder will take the wood, plaster, nails, plumbing, heating, and electrical components—everything but the foundation."—*Merle Henkenius*

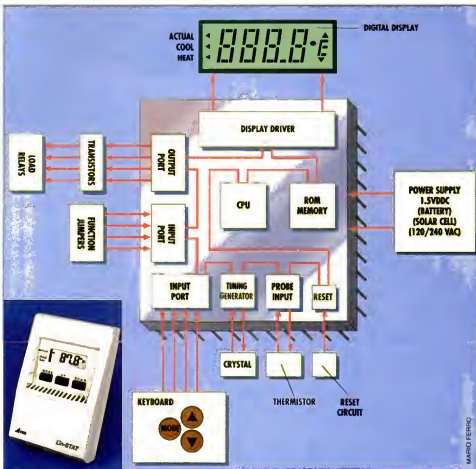
Though the panels could add 75 to 100 pounds to the weight of a standard refrigerator, this may not prove to be a problem. Some appliance manufacturers are considering increasing refrigerator weight anyway, to balance off weight gains that resulted when refrigerator doors were redesigned to provide additional storage capacity. —*Jerry Shine*

Update for baseboards

Electric baseboard heat suffers an unenviable reputation: It may be cheap to put in, goes the logic, but it's costly to operate and doesn't maintain a consistent temperature.

The blame rests partly with bimetallic-strip temperature control sensors. Slow to react, these mechanical sensors may allow temperatures to wander as far as 5°F to either side of the set point before switching the heater on or off. This wastes energy in two ways: By requiring the heater to raise temperatures as much as 8°F, baseboards draw current longer than necessary; and occupants who are chilled by the low end of the temperature swing may set the thermostat higher than they would otherwise.

A new type of thermostat, a micro-



With a thermistor, which alters resistance with temperature, an electric-heater thermostat saves energy.

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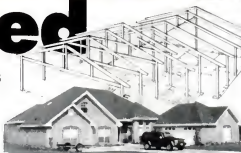


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Home Newsfront

processor-based digital line-voltage energy control made by PSG Industries of Perkasi, Pa., promises to correct these problems. PSG's control replaces the bimetallic strip with a thermistor, an electrical resistor that reacts to temperature variations by changing its resistance. The unit's microprocessor translates these changing resistance values into temperature readings, compares those with the set point, and switches the heater on or off as required. The thermostat thus reacts quickly enough to keep the room temperatures within 1.5°F of the set point.

While this increases comfort, it also saves energy. In field tests conducted on more than 100 thermostats in Pennsylvania, New Jersey, and New York homes, PSG found energy savings of 15 to 30 percent over bimetallic units.

The units will work only on "three-line" electric heating systems, not on the less common "two-line"; your system's manufacturer can tell you which type you have. Honeywell is working on its own design, to be ready sometime next year. —David Dobbs

Confirming green claims

Countering an explosion of environmental product claims from "biodegradable" to "ozone safe," home-center retailers are redoubling their efforts to ensure that product labeling isn't misleading consumers. At the recent National Hardware Show in Chicago, the National Retail Hardware Association and Home Center Institute (representing some 14,000 retail outlets) announced an industry-wide initiative to encourage scientific claim testing.

Leading the way is Home Depot, a home-center-store chain based in Atlanta that has an "Environmental Greenprint" education program. It suggests environmentally sound practices and products (without naming brands). The program covers subjects such as least-toxic pest control, indoor air pollution, energy-efficient and water-conserving products, recycling, and waste reduction.

Along with the hardware and home-center industry groups, Home Depot is asking manufacturers to undergo voluntary certification by Scientific Certification Systems/Green Cross based in Oakland, Calif. The organization inspects manufacturing facilities to verify green claims. Other stores are following the Home Depot lead: Portland-based Fred Meyer, Inc., is adopting Green Cross certification and distributes literature on recycling and composting. Also, Wal-Mart,

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Home Newsfront

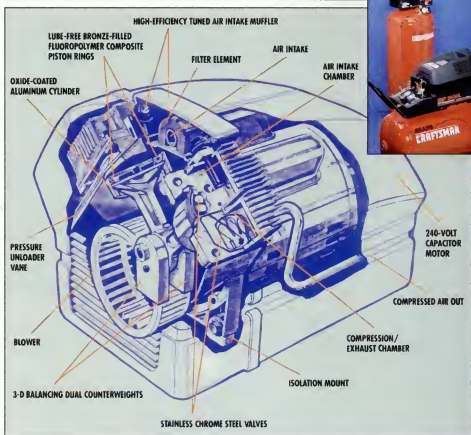
based in Bentonville, Ark., is building a store with the latest energy-efficient lighting and waste-reduction methods.—*John F. Wasik*

Breaking the six-hp barrier

In a first for oil-free compressors, Sears will offer a six-horsepower compressor with a 240-volt direct-drive motor. The motor has a unique twin-V configuration that makes it run cooler, last longer, and start more easily.

DeVilbiss of Jackson, Tenn., makes the Craftsman-brand compressors for Sears. Their air power is rated at 14.5 standard cubic feet per minute (scfm) at 40 pounds per square inch (psi) and 11.2 scfm at 90 psi. That's enough for serious house-painting; heavy-duty auto repair, finishing, and painting; major sandblasting; and running large air staplers and nailers. In many cases, you will even be able to run two air tools at once.

The horsepower is calculated using National Electrical Manufacturers Association specifications, which measure the torque at which the motor stalls out. Compressors that are rated at five hp, the previous oil-free limit,



An oil-free compressor with a unique V2 motor (above) will come in upright and portable versions (inset).

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Home Newsfront

are available from Sanborn of Eden Prairie, Minn.

The motor's patented 90-degree off-set piston design aligns compression rings to maintain better surface contact and load distribution, improving efficiency and reducing wear. A large blower wheel and shroud design works with specially shaped connecting rods and deep-drawn aluminum cylinders to dissipate heat. To reduce starting voltage and amperage, a fan-operated air vane bleeds off air pres-

sure when the motor speed is below operational levels. Dual crank counterweights provide three-dimensional balance to make the unit quieter, smooth-running, and easy to start.

The compressors will be available next spring. Fitted with a tool caddy, the wheeled 30-gallon-tank portable unit weighs 124 pounds and will cost approximately \$500; the vertical 60-gallon-tank unit weighs 180 pounds and will cost approximately \$500. The maximum operating pressure for both

units is 125 psi. For added safety, they will have air tanks that meet American Society of Mechanical Engineers (ASME) codes.—Phil McCafferty

More affordable solar

There's lots of sunshine in the southernmost states. But taking advantage of it with solar hot-water heating can be difficult, says Don Kazimir, president of Solar Development in Riviera Beach, Fla. At an average cost of \$2,500, "Solar hot-water heating has always been too expensive," he says. And the systems have usually been made for families of four, but "There are lots of smaller families who also want to save energy," adds Kazimir.

The less than \$700 Pacemaker system offers a solution. It was awarded the Solar Innovation Award from the Florida Energy Office in Tallahassee. The Florida Solar Energy Center in Cape Canaveral, which tested the system, says that it has a payback of two to six years for a southern Florida household of two or three people.

Pacemaker uses a two-by-ten-foot solar panel that has a copper absorber plate and black chrome coating; it provides 845 Btu of heat per square foot of collector surface. That's enough to heat 95 percent of the hot water used in a two-person home in Florida and other far-southern states.

Pacemaker's prefabricated plumbing components make it simple for the homeowner to install. "It's a weekend project," adds Kazimir. Instead of the usual 80-gallon solar tank, the system connects to the existing 40-gallon electric tank. The tank's electric element provides backup heat in cloudy weather. Solar Development, 3607-A Prospect Ave., Riviera Beach, Fla. 33404.

\$30 million refrigerator?

Encouraging consumers to save energy has become a fairly common way for electric utilities to level peak-period loads and avoid building costly new power plants. Now, in a new twist on the idea, a consortium of 26 utilities that serves one-fifth of all U.S. households is offering \$25 million to \$30 million in incentives to the manufacturer that comes up with the most efficient cost-effective refrigerator. (The number of utilities—and their incentive pool—could eventually grow.)

The winning refrigerator would use 25 to 50 percent less electricity than will be required by Department of Energy standards as of 1993—and none of the infamous ozone-destroying chlorofluorocarbons, or CFCs. (Refriga-

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tors use CFCs in their foam insulation and as refrigerants. The chemicals are being phased out of use.) In December, two semifinalists will be chosen to build prototypes by June 1993.

The utility consortium intends to use the incentive pool to subsidize the cost of each of the mass-produced winning refrigerators—which will likely be more expensive to manufacture than conventional models—so they can be sold at a competitive price.

"Refrigerators use 25 to 30 percent of the average household's electricity," says Richard Harkness, executive director of the Super Efficient Refrigerator Program, in Sacramento, Calif. Refrigerators made 20 years ago—many still in use today—consume some 1,500 to 1,800 kilowatt-hours annually. While the average new refrigerator uses just 900 kilowatt-hours, the consortium is hoping to find one that uses still less energy: 300 to 500 kilowatt-hours. "That would save the average homeowner up to \$200 a year in electric bills over a 15-year-old refrigerator," Harkness adds.

Notes from home

- They're not much to look at, and cockroaches are an annoyance from another viewpoint as well: They cause problems for asthma and allergy sufferers, say researchers from the Johns Hopkins School of Medicine in Baltimore. In a recent study, the researchers found the unappetizing culprit: a series of allergy-causing proteins in cockroach excrement.

- *The Efficient House Sourcebook* by Robert Sardinsky and the Rocky Mountain Institute staff provide lists and short descriptions of the best periodicals, organizations, catalogs, and books on all aspects of resource-efficient housing. Interesting to read in itself, the \$15 directory is available from the institute (1739 Snowmass Creek Rd., Snowmass, Colo. 81654).

- If a power outage leaves frozen meat to thaw in a freezer for 36 hours, it's best to throw it out, according to a recent study at the Ohio State University in Columbus. "By then, the number of microbes per gram has reached approximately one million," says Herbert Ockerman, professor of animal science at the university. That level is a measure of food safety for common microbes.

- Sheetrock First Coat works to eliminate uneven surface areas where joint compound connects drywall boards, says maker USG Corp. of Chicago. The primer/sealer equalizes the differences in porosity and texture between

drywall and joint compound to create an even absorption of paint—making the joints virtually invisible.

- The \$50 Safer Home Test Kit packages five indoor-air-quality tests in one box: There are tests for radon, lead, excess carbon monoxide, leakage from microwave ovens, and ultraviolet-light radiation. DSK Safer Home Test Kits, Beverly Hills, Calif. 90210.

- When a story about 3M's industrial-strength tape ran in "Home News-front" (Feb. '90), the company was del-

uged with requests for a consumer version. Partly as a result, this year 3M introduced two adhesive lines, for home and automotive use—including the Heavy Duty Attachment Adhesive. The tape permanently affixes rigid plastics, ceramic, metal, finished woods, and glass. Its industrial-strength bond endures through temperatures from 200°F to -30°F, outdoor weather, and vibrations. A package of four three-by-one-inch strips costs about \$3. MS

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DENNIS GRAY

Sitting dead in the water, *Yamato 1* looks like a rocket. It doesn't take off like one, though. During its first sea trial in June, the streamlined ship didn't even move fast enough to throw a wake.

Yet that maiden voyage could become as important in marine history as the 1807 launching of Robert Fulton's steam-powered *Clermont* or the *Nautilus* submarine's first trip under nuclear power in 1955. *Yamato's* propellerless technology may eventually move ships faster and with less noise than any propulsion system yet developed. But with *Yamato* achieving a speed of only slightly more than six knots (about seven mph) as it glided through the harbor in Kobe, Japan,

SUPERCON GOES TO SEA

**With no propellers to slow them down,
ships and submarines powered by
superconducting electromagnets may
one day cross oceans in record time.**

BY DENNIS NORMILE



DENNIS GRAY

Yamato 1, the world's first full-scale ship to use superconducting electromagnets for propulsion, made its maiden voyage in Japan's Kobe harbor in June. Crew members monitor the ship's performance from a cockpit loaded with electronic gear (top left).

the technology has a long way to go. Before magnet-driven ships can become competitive with conventional watercraft, researchers will need to develop superconducting magnets that are more powerful and lightweight than any known today.

In place of a propeller or paddle wheel, *Yamato* uses jets of water produced by a magnetohydrodynamic (MHD) propulsion system. MHD technology is based on a fundamental law of electromagnetism: When a magnetic field and an electric current intersect in a liquid, their repulsive interaction propels the liquid in a direction perpendicular to both the field and the current.

In *Yamato*, the liquid is seawater, which conducts electricity because of

the salt it contains. The boat's futuristic shape channels the seawater into two MHD thrusters on the bottom of the hull—one on each side.

Inside each thruster, the seawater flows into six identical tubes, arranged in a circle like a cluster of rocket engines. The ten-inch-diameter tubes are individually wrapped in saddle-shaped superconducting magnetic coils made of niobium-titanium alloy filaments packed into wires with copper cores and shells. Liquid helium cools the coils to -452.13°F , just a few degrees above absolute zero, keeping them in a superconducting state in which they have almost no resistance to electricity.

Electricity flowing through the coils generates powerful magnetic fields within the thruster tubes. When an electric current is passed between a

pair of electrodes inside each tube, seawater is forcefully ejected from the tubes, jetting the boat forward.

The MHD thrusters have several advantages over conventional propulsion systems. Most important, they will enable ships and submarines to travel at high speed. Visionaries anticipate speeds of up to 100 knots (about 115 mph), although researchers associated with the *Yamato* project regard that goal as extremely optimistic.

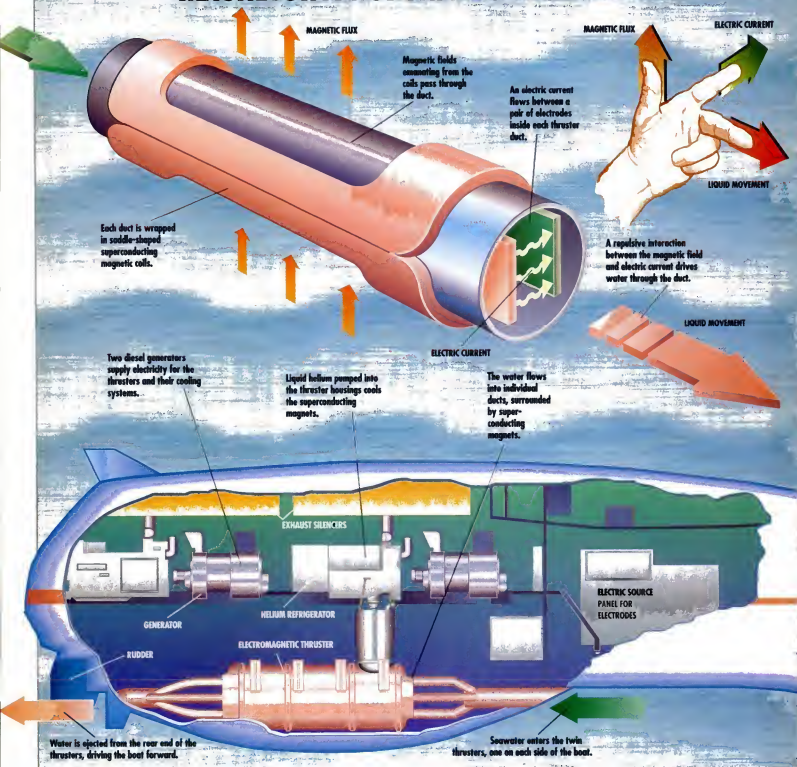
Kensaku Imaichi, professor emeritus at Osaka University in Japan and a key figure in the design of *Yamato 1*, believes the technology may have commercial ships cruising at 40 to 50 knots (46 to 58 mph) sometime in the next century. Speeds could go even higher if breakthroughs can be made in hull materials and ship stability.

DUCTIVITY



**Popular
Science**
NOVEMBER 1992

MAGNETOHYDRODYNAMIC PROPULSION AND THE



The speed of propeller-driven vessels is limited by a phenomenon known as cavitation. If the propeller turns too fast, an area of low pressure forms in front of the churning blades, causing the water to vaporize. This not only reduces a ship's efficiency, but can even destroy its propeller.

"By doing away with the propellers, we can avoid the phenomenon," says Seizo Motora, professor emeritus at the University of Tokyo and head of a scientific committee that designed *Yamato's* hull.

The second major advantage of MHD propulsion is silence. "There is no noise from a propeller, there is no noise from cavitation," Motora says.

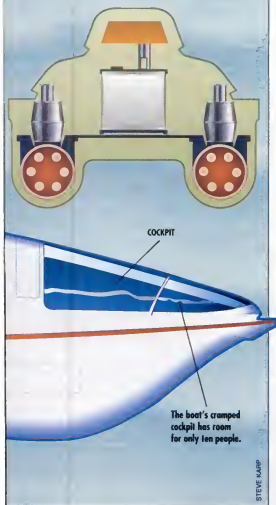
Silence is a central part of the plot of Tom Clancy's novel *The Hunt for Red October*, in which a Soviet submarine's noiseless propulsion system renders the vessel virtually undetectable by sonar. Clancy says that his fictional submarine propulsion system, dubbed the caterpillar drive, is not based on MHD technology. But the quest for stealthy submarines is what fuels in-

terest in MHD propulsion in most countries, including the United States (see American Stealth-Submarine Research on Hold).

Because MHD thrusters have no moving parts, they are not only quiet and vibration-free, but are also expected to have lower maintenance requirements than conventional propulsion systems. And with no need for a drive shaft to link the power source to the propulsion system, shipbuilders could experiment with new ship designs. Among the possibilities: cargo sub-

"LEFT-HAND RULE"

The "left-hand rule" is a simple method for calculating the interaction between a magnetic field and an electric current in a liquid. If you hold your left hand in the position shown in the drawing at left, you can use three of your fingers to represent the three forces at work. With your thumb pointed in the direction of magnetic flux, and your index finger pointed in the direction the electric current flows, your middle finger will indicate the direction in which the liquid will move as a result of the repulsive interaction between the magnetic field and electric current. You can test this rule on the drawing at far left, which shows one of Yamato's thruster ducts. Six of these ducts are arranged in a circle within each of Yamato's two thruster pods (below). Diesel generators and cooling systems fill most of the remaining space inside the boat (bottom).



Hoisting *Yamato 1* from the water exposes its unique hull design. This view shows the boat's thruster outlets.

marines shaped like jet airplanes and catamaran-style ocean liners.

A primary goal of the consortium that built *Yamato 1* was to revitalize the stagnant Japanese shipbuilding industry. The Ship and Ocean Foundation, a private organization that sponsored the \$40 million project, received research and manufacturing support from Japanese giants such as Toshiba, Kobe Steel, and Sumitomo Electric. Mitsubishi Heavy Industries supervised the construction of *Yamato 1* at its shipyard in Kobe.

The Japanese researchers aim to develop fast, fuel-efficient commercial ships that could eventually ferry California oranges to Japan in less than a week, a trip that currently takes about two weeks. The technology might even be used to construct large cargo submarines, which could dive below the ocean surface to avoid storms. MHD propulsion might also be used in submarine ferries that would transport passengers between Japan's numerous islands.

If the Ship and Ocean Foundation has its way, MHD technology will never be used for military gain. "We will restrict the use [of the technology] to peaceful purposes," vows Yohei Sasakawa, director of the foundation and chairman of the steering committee for the *Yamato* project.

Like many technologies now being developed in Japan, MHD propulsion was first proposed by American scientists. Several researchers published papers on the subject in the early 1960s. A few years after the first papers appeared, Stewart Way, a Westinghouse Research Center consultant who collaborated with an engi-

neer at the University of California at Santa Barbara, used an MHD thruster to propel a small model submarine. But Way used ordinary magnets rather than superconducting ones, and scientists concluded that the technology would have to await more efficient methods of generating strong magnetic fields.

In 1968, a report on Way's research reached Yoshiro Saji, who had recently joined the faculty of Kobe Mercantile Marine University. Saji had been looking for some way to apply his specialty—cryogenics—to ships.

Saji had worked with liquid helium and knew of its role in superconductivity. With a boiling point of 4.2°K (-452.13°F), liquid helium is used to cool superconducting alloys down to their critical temperature—the temperature at which electrical resistance disappears.

Saji realized that the strong magnetic field required to boost the efficiency of MHD propulsion could be generated by a superconducting coil. He spent five years on theoretical work and started actual experiments in 1973. In 1978, Saji and a group of colleagues succeeded in propelling a superconducting MHD model ship through a tank of seawater. There was only one problem: The miniature ship wouldn't go straight.

"No matter what we did, it always turned. I thought it was really strange," Saji says.

The model was 4.5 feet long, with the superconducting coil and electrodes in a fin sticking straight down from the bottom of the boat. The coil was a simple oval immersed in a liquid helium bath, and the electrodes were placed above and below the coil. In this arrangement, called an external-field system, the electromagnet does not surround a water-filled duct. Instead, the magnetic field is projected into the open water below the boat. That was the problem.

Earth's magnetism increased the strength of the magnetic field on one side of the fin and decreased it on the other, generating more propulsion on one side of the model. When Saji had the water tank reoriented along a line from magnetic north to south, the boat went straight.

To avoid the influence of Earth's magnetic field, the superconducting coil and the electrodes were



MITSUBISHI HEAVY INDUSTRIES

laid horizontally on the flat hull of Saji's next model. In 1983, this 1.1-ton, 11.5-foot-long model achieved a speed of 2.5 feet per second.

Saji's work attracted the attention of Sasakawa, scion of a wealthy philanthropic family with longstanding ties to Japan's shipbuilding industry. Sasakawa asked for Saji's cooperation in taking the work under the aegis of the family-dominated Japan Foundation for Shipbuilding Advancement, now known as the Ship and Ocean Foundation. The foundation recruited scientists from industry, government, and academia to take part in the design of *Yamato 1*—the ship's name comes from one of the earliest civilizations on the Japanese islands. *Yamato* was also the name of a massive World War II battleship sunk by Allied planes in 1945 as it headed toward Okinawa.

Scientific committees assigned to tackle various aspects of the ship's design began their work in 1985. The committee designing the thrusters

soon decided to adopt an internal-field system. The researchers were worried that the uncontrolled magnetic fields emanating from an external-field system might affect other boats and the marine environment.

The committee built a small internal-field thruster, loaded it in a model, and successfully sailed it through a tank of water. The thruster had a superconducting coil wrapped around a single water duct.

For the actual ship, however, the thruster committee decided to arrange six ducts in a circle. The committee members claimed this would virtually eliminate magnetic radiation leakage, because the stray flux emanating from one coil would be drawn into its neighbor. (The effects of magnetic fields on the human body are unknown ["Electromagnetic Fields: In Search of the Truth," Dec. '91].)

While models demonstrated the MHD technology, scaling it up proved troublesome. The first sea trial, two years behind schedule, was cut short

when "quench" warning signals lit up in the ship's cockpit. Quench is the phenomenon in which a superconducting coil slips out of the superconducting state.

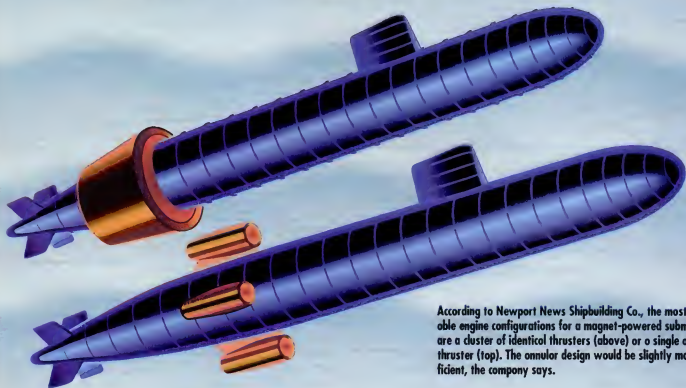
"Even if an unimaginably small portion of the coil slips into ordinary conducting mode, it generates an enormous amount of heat, which propagates throughout the system," explains Imaichi, who heads the thruster committee.

A sudden rise in temperature could destroy the coil, so *Yamato 1* is wired with sensors that constantly check for anomalies that might presage quench. "If the sensors are too sensitive, that interferes with ordinary operation," Imaichi says.

That seems to have been the case on the maiden voyage. Apparently, heat leaking through a gap around some electrical lead cables set off the warning signals.

The signal glitch was a minor detraction from the day's success. In just seven years, the Japanese team had

AMERICAN STEALTH-SUBMARINE RESEARCH ON HOLD



According to Newport News Shipbuilding Co., the most suitable engine configurations for a magnet-powered submarine are a cluster of identical thrusters (above) or a single annular thruster (top). The annular design would be slightly more efficient, the company says.

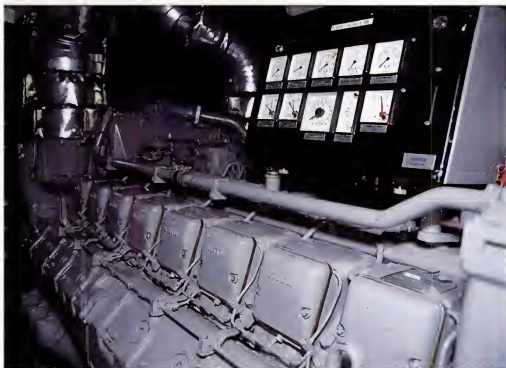
Although the United States pioneered the development of magnet-powered ships in the early 1960s, the current American research effort in this area can be summed up in one word: negligible.

No U.S. government agency has serious plans for building a ship or submarine with magnetohydrodynamic (MHD) propulsion. A few groups, however, have built MHD "thrusters" in the laboratory. In the largest project,

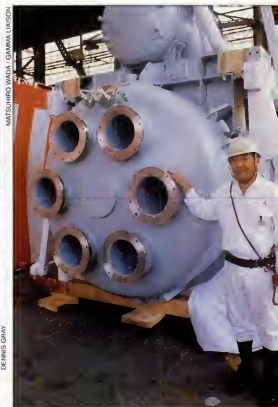
researchers at Argonne National Laboratory in Illinois used a 21-foot-long superconducting magnet—30,000 times stronger than Earth's magnetic field—to propel water through an 18-inch-wide duct, simulating the action of an MHD jet in the open ocean.

Researchers at Newport News Shipbuilding Co. in Virginia and the Naval Underwater Systems Center in Newport, R.I., have conducted similar experiments, smaller in scale.

The conclusion from these studies? "There's no showstopper" that will make magnetic propulsion impractical, argues Michael Petrick, who led the Argonne team. The key to building an MHD-powered vessel, he says, is designing lighter and more efficient magnets. Although the Argonne experimental thruster was several times more efficient than those in Japan's *Yamato 1*, it nevertheless wasted about 60 percent of the force gener-



Electronic sensors monitor the temperature of superconducting magnets and other conditions inside the thruster compartment (above). Each thruster contains six individual water ducts (right).



DENNIS GIAN

ated by the magnet. Furthermore, the stainless steel magnet weighed 180 tons—far too heavy for a ship.

Another limitation of the technology is that MHD ships will not work in areas with significant amounts of fresh water, which does not conduct electricity as well as salt water. Thus it might be difficult for an MHD ship to dock at many major ports, says Mike Superczynski, an expert on superconducting magnets at the David Taylor Research Center in Annapolis, Md. Also, salt water would quickly corrode the electrodes in the thrusters, Superczynski argues.

Both the Argonne and Newport News Shipbuilding projects are now on hold, pending more government funding. "We've gone as far as we can go in the laboratory," says Newport News Shipbuilding's Rich Ranelone. "Our next step should be a demonstration at sea." Ranelone proposes installing a magnetic thruster on an existing research submarine.

He shouldn't get his hopes up. The Defense Advanced Research Projects Agency, which funds this type of work, doesn't have the money to keep MHD research afloat. "We've finished our program," says Captain Ted Rice, an undersea warfare expert at the agency. "There are too many other things we need to attack."

Navy brass aren't excited about MHD propulsion either, agree experts close to the service. "The Navy is not even vaguely enthused about the idea," says Alan Berman, a staff member at the Center for Naval Analyses in Alexandria, Va. The biggest potential drawback: The huge magnetic fields emanating from an MHD-powered submarine would make it easy for enemies to detect, even if it made no sound. An MHD-powered sub would also leave a trail of chlorine, created by the electrolysis of seawater. For now, it looks like the international race to build a magnet-powered ship has exactly one contender.—Robert Langreth

turned a laboratory curiosity into a full-scale moving boat.

Making it practical, however, is a bigger challenge. *Yamato's* thrusters, refrigeration systems, and twin 2,000-kilowatt diesel generators virtually fill the 98-foot ship, leaving room for a crew of only ten in a cramped cockpit. The equipment weighs 143 tons, or about 70 percent of the total vessel displacement of 204 tons. By comparison, the propulsion systems of current oceangoing freighters typically account for less than 10 percent of the total displacement.

The maximum efficiency expected from *Yamato 1* is less than 4 percent. The efficiency of current commercial ships ranges from around 22 percent for hydrofoils to 60 percent for cargo ships. And a first-rate sculler can propel himself along faster than *Yamato 1*, which has a top speed of only eight knots (9.2 mph).

For MHD propulsion to become practical, researchers will have to develop magnets that are much lighter and more powerful than current ones. *Yamato's* coils now generate a maximum magnetic field of four tesla. Imaichi thinks the magnetic field can be raised to 30 tesla within the next two decades, and that this improvement will result in an overall efficiency of between 22 and 23 percent. This, he says, is comparable to the current efficiency of hydrofoils. "An MHD ship can be competitive with that kind of ship," Imaichi says. But to date, the maximum steady-state magnetic field achieved using

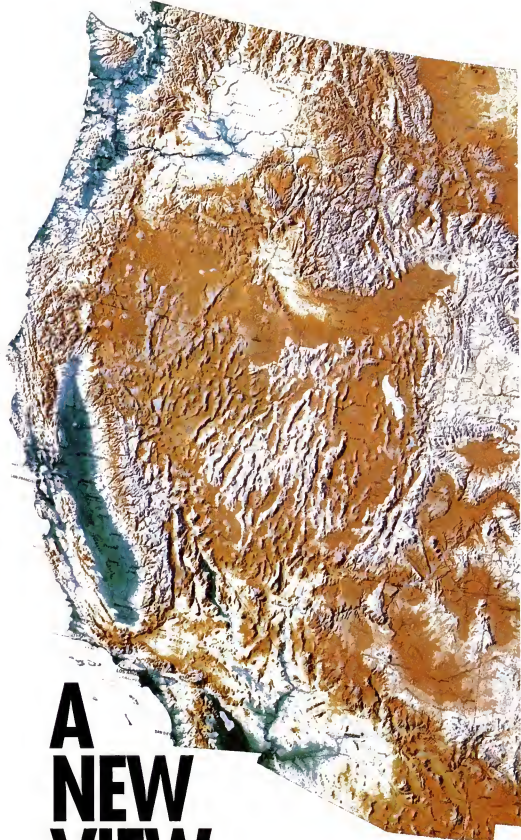
superconductors has been about 20 tesla.

Incremental improvements will come from using superfluid helium, which can cool the superconducting coil down to 1.8°K (-456.45°F), allowing increased current and thus a stronger magnetic field. Superconducting niobium-tin alloy filaments will also provide stronger fields, but the material is much harder to form into wires than the niobium-titanium alloy used in the present coils.

A leap forward could come with the refinement of new ceramic superconducting materials, which weigh as little as one-third as much as metal superconductors currently available. More important, with critical temperatures above 77°K (-321.09°F), the ceramics are "high-temperature" superconductors. This means they can be cooled with liquid nitrogen, which is less expensive and easier to use than liquid helium.

Taking these possible advances into account, Imaichi and other researchers have concluded that the ultimate efficiency of the technology will be somewhere around 50 percent, equivalent to the efficiency of current cargo ships. Hoping for the technological breakthroughs that will make MHD propulsion competitive with conventional ships, Sasakawa and his colleagues intend to build a second-generation MHD ship.

"It took 130 years for Watt's steam engine to be put to practical use on a ship," Sasakawa explains. "If you don't have dreams, you can't make progress."



Strip away the veneer of roads and cities and vegetation that clings to the top few feet of Earth's surface. Look at the wrinkled, toothy, and nearly smooth areas beneath. See the foundation of a continent as a space probe sees the terrain of a lifeless planet. Cartographers and geologists have a word for what's there: landforms.

Using digital image-generation technology, scientists at the U.S. Geological Survey (USGS) in California have produced the largest and most accurate map available of the country's naked landscape. It provides a glimpse at machine visualization of topography, a powerful tool earth scientists are using to create and enhance three-dimensional-looking images of terrain from data stored in magnetic or optical memories.

The landforms map owes its existence to a tedious, labor-intensive project undertaken from 1964 to 1972 by the Defense Mapping Agency's Topographic Center. Working from thousands of existing local topographic charts compiled as early as 1947,

Maps generated from a computer database reveal unfamiliar subtleties in the continent's complexion.

BY STUART F. BROWN

**A
NEW
VIEW
OF**

AMERICA

teams of Army personnel used manual digitizing devices to painstakingly trace along countless fine elevation-contour lines and store their coordinates on computer tape.

When the Army gave the database to the USGS in 1974, it contained a staggering number of elevation measurements—more than two billion—later edited down to 12 million data points. Last year, geographer Gail P. Thelin and geologist Richard J. Pike ran the Army's digital elevation model through a computer using image-processing software originally developed for manipulating Landsat satellite images of Earth. It took the computer 17 minutes to generate the black and white shaded-relief map on page 89 by calculating ground slope, sun position, and the location of the observer to assign each of the millions of pixels a brightness value.

The system let the scientists toy with the sun's intensity, location, and elevation angle in an imaginary sky to highlight favorite terrain features. Map-making convention puts the sun in the northwest at 45 degrees above the horizon. But as a specialist in geomorphology (the study of the origin and evolution of landscapes), Pike was interested in a much lower sun elevation angle that would cast shadows revealing the hidden contours of the Midwest.

"The Midwest is full of interesting glacial versus non-glacial border features that no one has seen before. Drawing attention to them was an important goal in making the map," he explains. "Being able to move the sun around lets you see the terrain in ways that you can't with God's illumination. Each angle catches details that are roughly perpendicular to the light source. We can shine the sun from the north or southeast and highlight features that would otherwise be invisible."

Cartographer Stuart Allen of Raven Maps & Images in Medford, Ore., contributed to the project by adapting existing images of coastlines and the 50 largest lakes for superimposition onto the USGS terrain image. Then he decided to develop a "hypsometric," or ele-

The map on these pages reveals information about terrain—and human activity—through elevation tinting. The dark green diagonal area (left) near the Pacific coast is California's vast Central Valley. At right, note the even progression of the tint from beige to light brown westward across the Great Plains. Steam locomotives climbing this steady grade needed boiler water every 20 miles, hence equidistant towns sprung up at the railroad stops.

RAVEN MAPS & IMAGES





New York City's importance as an early gateway to the New World was due to its deep-water port and proximity to the Mohawk Valley. The site of the Erie Canal, this valley is the only near-sea-level route to the Great Lakes and the continent's interior. It appears as a horizontal greenish line intersecting the north-south Hudson River Valley at a right angle.

vation-tinted, version of the landforms map using color to express height. The result draws on a blend of digital and artisanal mapmaking methods.

Allen's team worked by hand applying 22 colors to signify local terrain elevations and also added rivers, more lakes, and what cartographers call "culture": subtle grayish lines and type indicating cities, towns, major roads, and state borders. The addition of color and these reference points transforms not just the map's appearance, but also its information content.

"When you see the black and white and color maps together, you realize they show two different classes of information," Allen says. "There's no such thing as a map that shows you everything. One that tries to will give you visual and mental overload, and end up showing you nothing."

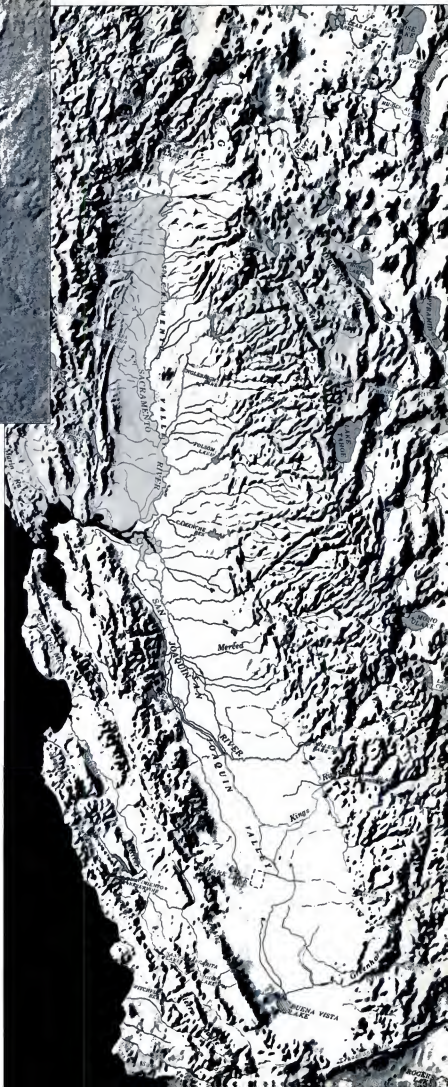
He likes to point out regions where color can highlight links between geography and history. "Look at the greenish east-west line running across New York state. It lets you see very clearly why New York City has always been so important—because it's accessible to the Mohawk Valley, the only place where you could get into the Great Lakes and the interior of the continent at water level."

Scientists around the world are adopting machine visualization technology to generate maps that are useful in their work. A shaded-relief map of Italy was recently produced this way. Before too long, people in many countries may be able to own a portrait of their homeland's bedrock. MS



U.S. GEOLOGICAL SURVEY

Digital cartography methods have made unseen features of the nation's landscape visible for the first time. The USGS map above uses stark shadows cast by a low-angle computer-generated "sun" to reveal the little known Cateau des Prairies, a 200-mile-long delta-shaped landform in eastern South Dakota. The intriguing low-relief formation is a deposit of hard quartzite that split the southward-flowing glaciers of the last ice age into two lobes. Ice scoured the lowlands on either side, but never covered the Cateau itself. Artificially stripped of all vegetation, waterways, and man-made features, the view looks like one of another planet.



Compare the closeup at right of California's Central Valley with the elevation-tinted map showing the same region on page 86. The tints express how high features are. On the other hand, the strength of black-and-white landforms imagery is its ability to express texture. For example, relief shading highlights Sutter Buttes, the eroded remnants of an ancient volcano located near the valley's northern end. Once an inland sea, the Central Valley's virtually flat floor is composed of several thousand feet of sediment washed in from the adjacent mountain ranges. This detail is taken from the Raven Maps & Images edition, which adds rivers and small lakes.

"Out-powers Ford and Chevy hands down."

—Certified by SCORE International, January 1992

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¹Dakota 4x2 Club Cab out-paces Ford & Chevy (outdoor extended cab) empty, w/960 lbs payload & w/5,950 lbs combined payload & trailer weight. All trucks equipped with auto, trans, & max. avail. axle ratios. Graph not proportional to test data.
²Overall total combined power scores. All engine and comparisons based on '92 models/data.

A vintage television set is shown against a dark background. The screen displays the words "Tech TV" in a large, white, pixelated font. To the left of the TV, there are vertical lines of light, resembling a film strip or a digital display, with a blue and orange color scheme.

Tech TV

ew-generation television gear, bristling with digital technology, promises to dramatically enhance picture-quality—and add two-way interactivity to your viewing. This three-part report details a new signal that can banish ghosts from TV screens. Also, some new sets deliver pictures in a wide-screen format, just like in movie theaters. Other TVs double the number of scan lines to bolster picture quality. And to energize couch potatoes, adapters for TVs—linked to complex two-way networks—promise new services and entertainment.

Interactive Television



Couch potatoes are talking back to their TVs as two-way gadgetry, video compression, and new delivery methods are plugged in. Tapping into the technology is a smorgasbord of new services.

BY MICHAEL ANTONOFF

A t TV Answer's headquarters in Reston, Va., I point a wireless joystick at a small black box atop a TV set. A menu of icons representing TV listings, a shopping mall, and other services appears on the screen, superimposed over a local program. I move a four-headed arrow on the screen to CREATE A CUSTOM PIZZA and press the remote-control trigger. Now the CHOOSE A TOPPING menu appears, listing pepperoni, sausage, fresh mushrooms, green pepper, and others. These video toppings can be "maneuvered" to cover a whole pie or half of one.

If I were at home in San Francisco, I would be reclining on a sofa and flicking my wrist like a conductor directing a pizza symphony. And if I subscribe to TV Answer's interactive-TV system slated to start next year in major cities, here's what would happen: Clicking the remote control completes my selection. A pizza-order signal is broadcast from a stubby antenna behind the black box, picked up at the nearest receiver-cell site in the city, and beamed from a dish antenna to a geostationary satellite 23,000 miles over the equator. Then the signal is downlinked to one of TV Answer's big dishes behind its tree-lined parking lot in Reston.

That's half the trip. Next the order is relayed to a room-size computer in a nearby building that can handle 20,000 transactions a second. My account is debited and my selection—including a hold-the-anchovies request—is dispatched to a pizza chain's national headquarters. Pizza HQ contacts the store nearest my home and they begin making the pie. Elapsed time for the transaction, claims TV Answer, is just six seconds.

A silly example of interactive TV's potential? "When the only tool you have is a hammer, all your problems look like a nail," shrugs David Serlin, executive vice president of ICTV, creators of a competitive two-way technology designed to run on cable systems. Serlin suggests that we don't have to attempt *everything* with interactive systems. Just pick up a phone and talk to the local pizzeria, he says. "It's ten times faster than going through a whole electronic selection process."

Interactive TV, which creates a two-way link between the viewer and the information or programs on television screens, lets you talk back to your set. After a decade of false starts and failures, dozens of new companies are poised to launch interactive systems during the 1990s. A few are operating now. Despite the hype from some interactive-TV firms, though, not all of them will succeed.

The promises are elaborate. Everyone from cable-TV operators to over-the-air entrepreneurs claim their gadgetry will, for example, learn your tastes, filter your news, alert you about preferred types of upcoming movies, print coupons and tickets, let you play along with game shows, present fashion catalogs, and order virtually anything for you. They will also display your bank account and make transactions.

What makes all of this possible is the arrival of inexpensive but powerful microprocessors, ingenious video-compression techniques, and a variety of delivery technologies—all backed by communications, computer, and entertainment giants.

Some of the new hardware even seems to have a mind of its own: An interactive system I used at home features a TV-gamelike controller with a three-foot antenna for FM reception.

Recently the controller decided to take a half-hour out, pulling data from the air to upgrade its own software. DON'T TOUCH, warned its display.

One of the most ambitious interactive-TV systems involves new cellular-radio networks dedicated to Interactive Video and Data Services (IVDS); TV Answer will use such networks. A tiny slice of the radio spectrum above VHF Channel 13, between 218 and 219 megahertz, is allocated for IVDS. Much like cellular-telephone systems, regions are divided into antenna-based cell sites. About 20 sites would cover Manhattan, for example. TV Answer sites will each be equipped with a radio transmitter-receiver and a small satellite-dish Earth station. The Federal Communications Commission is licensing two IVDS providers in each region to promote competition.

Home gadgetry is simple. Subscribers to TV Answer systems will at-

Tested initially in a few California cities, Interactive Network's system may go nationwide next year. A two-way data-communication link involves FM or other broadcast stations, but users must complete the link through their phones.

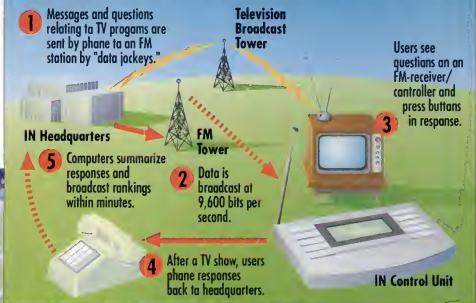
tach a small transmitter-receiver to their TVs. A four-inch antenna on this device sends and receives data to and from the nearest cell site. With one menu selection, for example, you will be able to check TV program listings and set your VCR. Other menu options might let you guess upcoming plays during sporting events, answer on-screen questions to play along with quiz shows, or participate in polls.

Although the home receiver-transmitter design is still changing, the devices will include wallet-size memory cards to store data for banking, shopping, paying bills, and more. The cards will also provide additional memory capacity. TV Answer may include a low-resolution printer to dis-

pense coupons, recipes, or receipts. Such TV-linked printers will become very popular, according to companies such as Interactive Systems of Beaverton, Ore. In Europe, this company is test marketing InTouch TV. A box, which sits on top of the television set, prints "Viewpons"—coupons tied to commercials that viewers select with their remotes.

The Hewlett-Packard Co. of Palo Alto, Calif., is slated to manufacture and market 1.5 million TV Answer home receivers initially. The price, TV Answer hopes, will be less than \$500. Costs for on-screen services will range from nothing to several dollars for play-along games and similar selections. Some industry analysts, howev-

JOCKEYING DATA ON AN INTERACTIVE NETWORK



er, are skeptical about the economics of building an expensive cellular infrastructure, which would cost consumers hundreds of dollars to use.

One company, Interactive Network (IN), has been broadcasting its two-way service to Sacramento and San Francisco Bay area households for more than a year. Customers buy a \$199 hand-held data receiver with a small liquid-crystal-display (LCD) screen, keyboard, antenna, memory, and built-in modem. There's a \$15 monthly charge for basic service; an optional \$10 charge buys tokens for prize competitions.

"Data jockeys" at IN's studios in Mountain View, Calif., piggyback part of their interactive signal on the sub-carrier frequency of local FM stations. Text-based programs are broadcast to viewers and displayed on their lap-top receiver as they watch "Jeopardy," "Wheel of Fortune," "60 Minutes," drama, and sports events. As questions are being asked on "Jeopardy," for example, you choose the correct answer from a multiple-choice menu on the receiver LCD. Pressing the right button before contestants triggers a tone and a CORRECT! message on the LCD. I discovered you must train yourself to keep one eye on the set and the other on the sometimes hard-to-read LCD screen.

At the end of the show you plug the

receiver into your phone jack and dump your score into IN's central computer. Within about five minutes, a broadcasted graph appears on the LCD showing your rank compared with other home players. After my first play-along game, I learned that my score ranked in the 94th percentile. But it seemed like cheating when I slipped correct answers to a "Murder, She Wrote" episode into my receiver even as Jessica was solving the crime. IN's data jockeys failed to lock me out quickly enough.

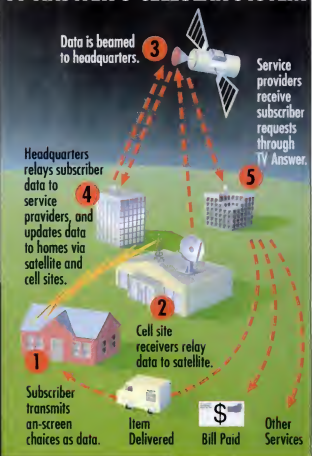
IN subscribers also use the system to predict upcoming plays for baseball games—at home or in the stadium. Last summer, to promote the service at a San Francisco Giants or Oakland A's game, IN loaned receivers to fans. The technology, I discovered, adds a new dimension to attendance: Beside rooting for your team, you want your predictions to come true. In a June game against the Houston Astros, the Giants were losing 8-0. But instead of being depressed, some fans enjoyed a game within a game by

scoring thousands of points with correct predictions.

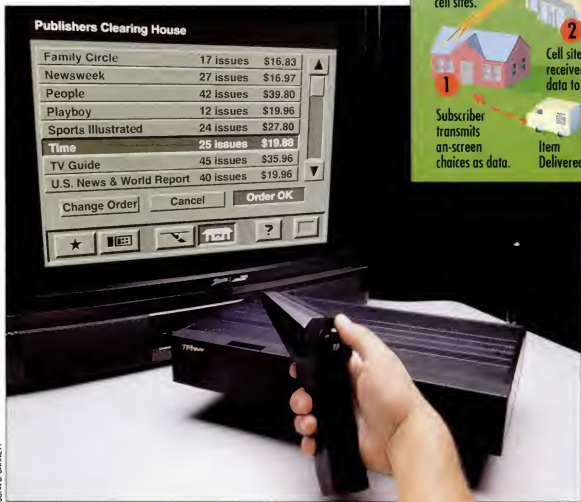
One couple in the stands, their antenna showing, shared a unit. Said the man, whose woman friend was outscoring him: "She's used this thing before," claiming to be a novice.

Ken Griffith, who works for an insurance company in Sacramento, says he and wife use separate control units. "We're competitive," he said. "For a while I'd been scoring higher in the game shows; now, Karen is scoring higher. We don't give each other the an-

TV ANSWER'S CELLULAR SYSTEM



Computers summarize responses and broadcast rankings within minutes. Set-top control units for the TV Answer interactive system will transmit and receive data between homes and local satellite-linked cell sites (above). Random-access and read-only memory cards will be plugged into the home controllers for special functions. Both the hardware and on-screen menus shown are prototype designs (left).



swers, and this makes watching TV a lot more enjoyable." And companionable.

Griffith pays \$30 a month to participate in the competitions. He has made it to an IN-organized "Wheel of Fortune" tournament where the top players get to meet each other and play a live game. He's aiming for a trip to Hawaii as a prize.

Since software for IN's receiver is stored in 256 kilobytes of battery-backed random-access memory, its programming can be automatically updated over the air. That happened once when I turned the receiver on but inadvertently left it idling on the couch. The receiver's built-in programming told it to capture the latest system upgrade from the air as well as display a message that it shouldn't be interrupted. I obeyed.

IN hopes to go national in 1993. Instead of delivering the signal over an FM station, though, it plans to pipe the data over an unused portion of Public Broadcasting Service signals. A booster amplifier in homes will decode the data and beam it across the room to the control unit. Jacks on the back of the control unit could accept a printer, computer, or mass-storage device.

One weakness of Interactive Network's scheme is that users must plug their receivers into a phone jack in order to make the system two-way. That may be too much interactivity for confirmed couch potatoes. Also, the program content on your TV screen is unchanged by anything you do from the IN control receiver.

A more direct approach is being planned by ICTV, a start-up company in Santa Clara, Calif. This technique uses coaxial cable-TV coming into homes—upgraded when necessary—as a bidirectional medium. Users would be able to alter programs and information on the screen as well as place orders. ICTV calls its approach "cellular cable." Advanced video-compression techniques are exploited to boost the signal-carrying capacity of standard cable. Each neighborhood would be divided into cells composed of about 150 homes linked by cable to a powerful PC or workstation.

The strategy, in effect, grafts an office local-area network onto neighborhood cell sites. A "smart" control box replaces the cable converter in each home. On-screen choices made with a wireless remote would be piped to neighborhood cell sites. Cell-site computers would be linked in parallel throughout cable systems; these computers would communicate with the cable systems' central computers.

At a converted warehouse near San

Jose International Airport, ICTV's president, W. Leo Hoarty, points to a working neighborhood cable system in miniature. Some 20 loops of black cable dangle from the wall.

"Call it LeoVision," he says. "We're simulating a real run of a feeder leg down the side street." His setup duplicates the signal loss of long cable lines, amplifiers, and taps. "The only thing missing is the local cable-TV pirate," Hoarty says.

A partitioned warehouse area has furniture and a TV set to simulate a living room. The unusual remote con-

trol sitting on a coffee table has a two-inch-wide touch-pad section as well as buttons. Slide a finger across the pad and a pointer on the TV screen tracks your fingertip.

Beyond standard basic and pay-cable channels, ICTV has folded several interactive channels onto the system. The company expects that "near-video-on-demand" will be its most popular service. The idea, already available on some high-capacity cable systems, provides a block of, say, 30 recent movies. With numerous tapes

(Continued on page 124)

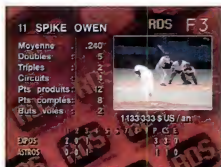
PICK-A-VIEWPOINT INTERACTION



The remote control's F1 button provides a catcher's-eye view.



The F2 button adds special statistics on the baseball game.



Pressing F3 delivers a view with updated batter data.



The F4 option on the remote control is a view of F1 with a ten-second delay.

In Montreal, subscribers to an interactive-TV cable system called Videoway can select four different views of baseball and hockey games, concerts, or other events. With an Expo game, for example, viewers can press remote-control buttons to switch camera angles or call up statistics relating to the game (photos above). Videoway's viewpoint feature is based on special tuning techniques between four channels developed by ACTV, a New York company that now focuses on technology in the classroom.

Scene switching is a small part of the system's capabilities. Videoway's two-way mode lets users send electronic mail to other subscribers or information-service companies. Products or services advertised on screen from electronic catalogs can be ordered and paid for with personal identification numbers. Banking and other transactions can be supplemented with an optional reader/printer that handles smart cards or prints out coupons and other information.

Bored with TV fare? The cable's wide signal bandwidth permits fast downloading of software and other data to personal computers. Video games for both education and entertainment can also be piped into homes. Another data service uses the Videoway converter for home automation, displaying images of appliances on the screen and controlling them with signals sent through alternating-current power lines. In addition to pay-per-view, other TV services include displaying captions encoded with some programs for hard-of-hearing persons, plus the teletext information also carried invisibly with some TV broadcasts. Some 170,000 people now subscribe to the service, according to Jean Paul Gallaneau, director of communications for Videotron.—M. A.

Ghost Busters



Blurry television images and smeared colors—the video ghosts that are the bane of 75 percent of TV households—will soon be a thing of the past. A new anti-ghost signal standard promises to clean up cable and broadcast transmissions fast and inexpensively.

BY MARCELLE M. SOVIERO



A clear, sharp picture of a zebra appears on a TV screen at Philips Laboratories in Briarcliff Manor, N.Y. The zebra's stripes and the surrounding colors of the jungle are crisp and rich. On the adjacent monitor in the darkened room, however, the identical scene is blurry, with distorted color and glitches in the picture. "Notice the ghosts," says Brian Smith, senior director of digital video business at Philips, pointing out the shadowy images outlining the zebra on the second screen—before they are electronically stripped away.

Such "ghosts" come in many shapes and sizes and can occur in multiple hauntings. They aren't particular about where they lurk, either. Nearly 75 percent of TV households in the

United States are plagued with these pesky poltergeists.

Home remedies for ghosting, such as repositioning TV antennas and crumpling aluminum foil around lead-in wires, have been the only—mostly ineffective—anti-ghosting treatments. Now, for the first time in the United States, a voluntary standard for broadcast, cable, and TV set makers has been finalized for encoding TV signals with a Ghost Cancellation Reference (GCR) signal. Many stations around the country have begun transmitting the signal with their broadcasts.

As a result, TV pictures could be "deghosted" with special circuits built into next-generation receivers. Direct over-the-air reception, often plagued with multiple ghosts, will see the biggest improvements. But cable subscribers will benefit too. Cable TV suffers from smaller ghosts, so-called micro-reflec-

tions, caused by broadcast signals leaking into cable lines. Now, cable companies can purchase hardware to help clean up signals before they are sent.

The first sets with ghost-busting features could appear before 1994. At first, they will most likely appear in high-end, direct-view, and projection TV models. The goal, however, is "to make the technology inexpensive enough for all TV sets," says Philips Laboratories president Peter Bingham. The added price for anti-ghost circuits, he says, should parallel picture-in-picture (PIP) features introduced several years ago. At first, PIP added several hundred dollars to the cost of a set; now it's a \$50 premium.

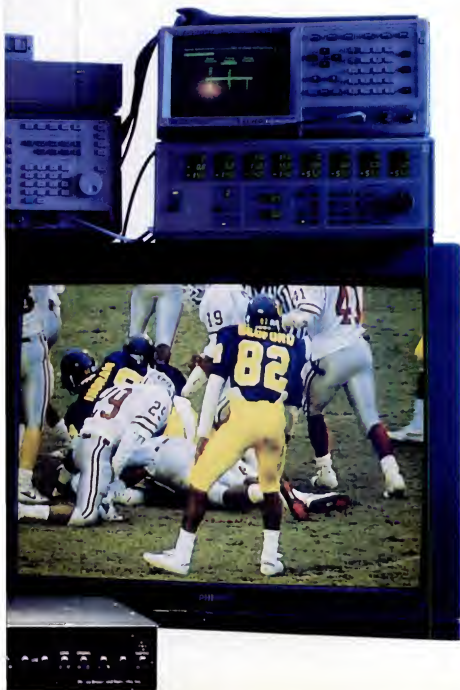
Ghosts are a result of signal interference; by definition, they're delayed copies of an original signal. Ideally, a TV signal travels only in a straight line. More often, though, broadcast signals reflect off tall structures as they travel from station antennas to home receivers or a cable company's antennas. Such reflections cause weaker delayed signals—ghosts—that reach your set an instant after the strong main signal. Result: You see the main picture cluttered with any number of ghosted images.

"A typical ghost on a 20-inch TV set will be two inches to the right," says Bernard Caron, manager of transmission technologies at the Communications Research Center in Ottawa, Ontario. Ghosts almost always occur to the right of the main picture because they're delayed, and images are scanned onto screens from left to right. It takes more time for a ghost to get to the TV than the real picture, Caron explains.

Urban areas have the worst problems. "Every building has the potential to cause ghosts, so if you live, say, in New York, there can be as many ghosts as there are buildings," says Michael Isnardi, head of TV systems research at the David Sarnoff Research Center in Princeton, N.J.

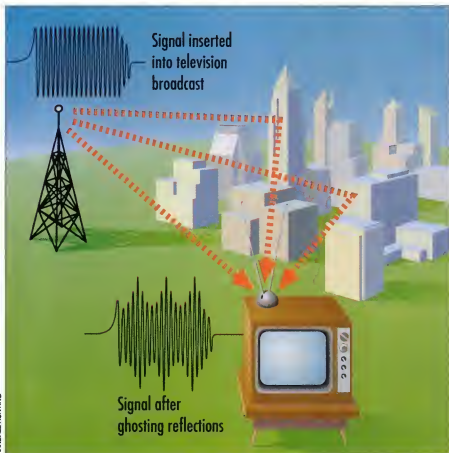
A ghost's position and strength hinge on its journey between the broadcasting antenna and your antenna. A signal delay of less than one microsecond (millionth of a second) creates short-delay ghosts, which blur pictures. If signals bounce from building to building, however, with delays of two to ten microseconds or longer, long-delay ghosts will create separate, distinct ghosting. Over-the-air broadcasts generally experience long-delay ghosts; cable signals are prone to short-delays.

Ghost-busting technology has been



A ghosted TV picture at Philips Laboratories (far left) is corrected using digital-signal-processing hardware to "clean up" the image (left).

GHOST BUSTING: SCANNING FOR SIGNAL DIPS



RANDALL HARTING

Ghost busting involves complete signal processing and starts with a Ghost Cancellation Reference (GCR) signal that is inserted by broadcast stations into the vertical blanking interval (VBI) portion of standard video signals. The VBI is the blank space between picture frames, visible whenever pictures "roll," that doesn't carry picture information. This GCR signal is a pulseline burst of both low and high frequencies. The flatness of the GCR pulse is perfect for ghost busting (top of diagram): While the signal and picture start out ghost-free, after reflecting from objects, recognizable dips develop along the GCR pulse (bottom of diagram). Since ghost busting is performed digitally, the receiving hardware converts the entire video signal into digital form. A comparison is then made with a stored GCR reference signal and the ghosted signal. Permanently stored programs (firmware) calculate the spacing of the ghost signals and help set up digital-filter chips capable of blocking the ghosted portions of the signal. These processing and filter chips are based on standard very-large-scale-integration technology. Because only a few chips are necessary, ghost cancellation is affordable. Once the video signal is stripped of ghosts it is transformed back into analog form for display on TV sets.—*M. M. S.*

slow to arrive in the United States. But finally, after completing tests of five systems earlier this year, including one used in Japan since 1989, the National Association of Broadcasters and the Advanced Television Systems Committee have endorsed a system engineered by Philips.

This system includes equipment that injects the standard GCR signal into TV broadcasts, plus a digital-signal-processing unit for receivers that removes ghosts. Philips' GCR signal carries at least 100 times more energy than the Japanese system (see Why Ghost Busting Got Spooked in Japan). As a result, it works in noisy conditions or poor reception areas, enabling processor circuits to differentiate between ghosts and "snow" in picture signals.

Ghost cancellation is fast—but not instantaneous. GCR signals inserted at the broadcast station are initially ghost-free, but degrade as they travel. Receiving hardware needs about two seconds, depending on the signal noise level, to cancel the ghost. The system compares an unimpaired GCR signal, stored in memory, and the degraded signal. Algorithms calculate the differences between the two signals and set up digital filters to electronically block the ghost signals.

As many as 20 ghosts can be handled at one time, says Amihai Miron, director of electronic systems at Philips. In urban areas, about ten ghost reflections are often present. The system also eliminates sporadic ghosts, such as those created by passing aircraft.

Although set makers are just starting to design ghost-busting features for upcoming home receivers, the results of ghost canceling may be seen almost immediately. Magnavox CATV Systems in Manlius, N.Y., offers ghost cancelers for cable TV companies. Soon, less expensive ghost-removal equipment, built into home receivers, will be available. MS

WHY GHOST BUSTING GOT SPOOKED IN JAPAN

A ghost-cancellation technique developed by Japan's Broadcasting Technology Association is part of a "hi-fi" broadcasting standard introduced there three years ago. The standard, called enhanced-definition TV (EDTV), also boosts the resolution of pictures. EDTV signals are compatible with standard TV receivers, but special sets or decoders are needed to display the sharper images or benefit from ghost reduction.

By the end of 1991, 112 of Japan's 116 TV stations were broadcasting with the Ghost Cancellation Reference (GCR) signal, according to a survey. Less than 10,000 TVs equipped with ghost cancellation had been sold, however. That's probably because most set manufacturers include ghost cancellation only in their EDTV models, which consumers have found is not worth the extra cost.

Japan's GCR signal, like the upcoming U.S. system, is injected into the vertical blanking interval between TV picture frames. Two types of waveforms are used for this signal. At the TV receiver, the ghost canceler identifies the broadcast GCR signals and compares

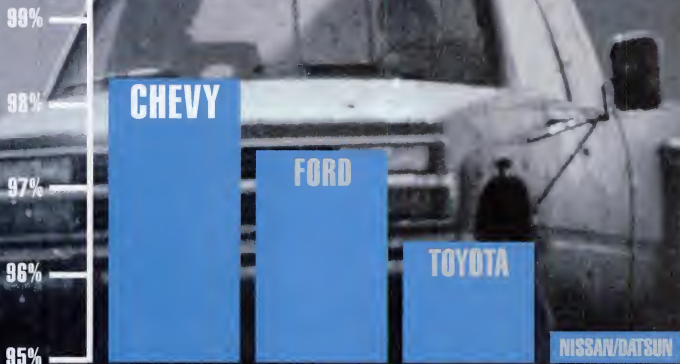
them with a stored signal to detect distortions in the broadcast signal produced by ghosts. A filter then removes similar distortions from the broadcast signal. All processing is digital, with the picture and GCR signals converted into analog form to drive the picture tube.

The developers claim this technology is capable of reducing any conceivable kind of ghost. One drawback: If the signal-to-noise ratio is small, the ghost canceler will mistake the noise for a ghost signal and add a pseudo-ghost. But, developers say, this is so small it's nearly unnoticeable.

Performance varies somewhat with the manufacturer. NEC Corp. claims its ghost cancellation can handle up to 16 simultaneous ghosts and clear them within three seconds.

NEC's most recent TV model is not EDTV but does incorporate ghost cancellation—an approach that may trigger similar use of technology by others. The 29-inch TV sells for about \$1,770, but includes additional features such as a built-in broadcast satellite tuner. A no-frills 29-inch TV is available for about \$770 in Japan.—*Dennis Normile*

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Wide



**TV screens shaped
like those in
movie theaters
bring an exciting
new dimension to
home viewing. And
a new generation of
improved-definition,
all-digital models
deliver crisper
big-screen pictures.**

BY MARK FLEISCHMANN

Picture a movie about new advanced-television receivers. The setting is a TV showroom: A camera pans slowly, stopping at a shopper hypnotized before a wall of glowing TVs. Some models have wide, cinemalike screens that set them apart. A few receivers, labeled improved-definition television (IDTV), have remarkably distinct pictures—free of visible scanning lines. *Flash back to...*

The year 1953. At an art deco movie house, a popcorn-toting teenager sits down to watch 20th Century-Fox's *The Robe*, the first film made in CinemaScope, the best-known of the wide-screen movie formats. *Cut to...*

The present. Our teenage movie buff—now a graying videophile—carries microwaved popcorn to his basement home theater. Nostalgically, he's about to watch a wide-screen laser-disc version of *The Robe*. His Vidikron projection TV, fed by an IDTV converter that doubles the number of lines on his giant wall screen, creates stunning pictures. They're similar to the sweeping wide-screen proportions he enjoyed nearly 40 years ago.

Until this year, only well-heeled video buffs could enjoy such elaborate, real-life private screenings. Now that's changing. Thomson Consumer Electronics has already introduced big-screen sets with the line-doubling IDTV feature; next year expect to see Thomson receivers with IDTV and wide screens. Philips Consumer Electronics and some Japanese companies will jump on the wide-screen and IDTV bandwagon. In addition, laser-disc and videotape companies are expanding their lineups of wide-format movies. And for would-be Cecil B. deMilles, several camcorder firms, including Thomson, now sell models that let you tape in a wide-screen format.

Another rare source of wide-screen movies: "letter-box" formats. TV stations and cable companies sometimes broadcast these pictures, which appear sandwiched between black horizontal bars on standard sets, but fill new wide-format screens nicely.

What about super-sharp high-definition-television (HDTV) broadcasts, which are also a wide-screen format? A U.S. standard for HDTV isn't expected



A wide-screen 54-by-100 inch Stewart projection screen adds extra realism to home theaters. Runco's Super-IDTV projector (right), includes a line-doubler (atop the projector) that eliminates visible scanning lines. An optional unit permits wide adjustment of the aspect ratio (picture height and width). The *Aliens* image is from a wide-screen collector's-edition laser disc.

Screen Video

until 1993. The sets probably won't be available before 1995 ["Digital HDTV," Nov. '91]. But for shoppers concerned about obsolescence, some very expensive projection TVs designed to handle line-doubled IDTV displays now include jacks for future HDTV inputs (a tuner, disc, or tape, for example). Most wide-screen sets slated to appear in stores soon, however, won't handle HDTV unless special signal converters

for the new format are also introduced.

TV format changes are rare. Americans still watch television that adheres to a 1948-vintage standard named for the National Television Systems Committee, which devised it. The NTSC standard isn't designed for big screens or even color, which arrived in the mid-1950s. As a result, most of the standard's 525 scanning lines are all too visible on large screens. And color, pig-

gybacked on the standard years after its adoption, tends to smear and create other image distortions.

Wide-screen sets expand the conventional 4-to-3 aspect ratio (width to height) of NTSC images to 16 to 9. This readily visible improvement may hook more viewers on advanced TV than the heightened sharpness of HDTV.

Thomson, Pioneer, Philips, and others say they intend to offer 16-to-9 aspect-ratio sets late this year or in 1993. Panasonic could introduce both 40-inch rear-projection and 34-inch direct-view wide-screen sets. Similar direct-view sets have also been demonstrated by JVC, Sharp, and Toshiba.

While not high-definition-caliber, IDTV sets could become a useful way station between the current North American standard and the high-definition standard to come. Unlike HDTV, IDTV and wide-screen television are not pie-in-the-sky promises being evaluated by some government testing panel. They've been on the video scene for years—assuming letter-box laser discs qualify as one form of wide screen. And they're here to stay.

IDTV is not a new television standard but an attempt to "improve" NTSC images by using digital memory to double the scanning lines from 525 to 1,050 (the same number as two proposed digital-HDTV formats). The pictures that result are only slightly more detailed than unretouched NTSC images because the signal does not contain any new information. Vertical resolution is enhanced, manufacturers say, because 1,050-line IDTV images are displayed all at once, in $\frac{1}{60}$ of a second. Normally, you see 525-line TV pictures in two interlaced halves, each $\frac{1}{60}$ second apart. But the doubled lines on improved-definition sets are small enough to disappear, at least to the naked eye. That sense of transparency, not heightened detail, is part of IDTV's attraction.

In addition, line-doubling helps eliminate the interline flicker caused by standard interlaced scanning, which mars the horizontal borders of objects. By separating the color (chrominance) and brightness (luminance) parts of the video sig-



PHOTO: JOHN B. CARNETT—ALIENS IMAGE © 20TH CENTURY FOX AND COLUMBIA. ALL RIGHTS RESERVED.

nal, and thus preventing the former from leaking into the latter, IDTV zaps the crawling dots that often mar weather-report graphics, for example. The improved digital separation of signals also helps prevent cross-color in-

terference—the barber-polelike patterns on a tweed or striped garment.

Improved definition comes at a cost. Sets introduced by Philips, Toshiba, Sony, Panasonic, and NEC in the late 1980s were steeply priced ["Sharpies!"

Nov. '88]. Also, IDTV images retained their apparent fine-grain superiority only if little or no movement occurred within images. With rapidly moving objects, images blurred because early IDTV circuits weren't fast or powerful enough to avoid so-called motion artifacts. Newer circuits, although still imperfect, are better with motion—sometimes significantly better.

None of the original IDTV models has remained in its maker's lines. Brian Smith, senior director of digital video business for Philips whose 27-inch set was among the first IDTVs, says the early experience taught some valuable lessons. One is that IDTV is meant for big screens. "Twenty-seven inches didn't make sense because when you sit at a normal viewing distance you hardly see the difference," says Smith. With larger screens, such as the 32-inch model introduced later by Philips, the difference from line-doubling is more noticeable.

Panasonic and NEC equipped their big-screen rear-projection sets with IDTV. NEC's 52-inch ID3 was particularly stunning—at least when the picture stood still. And Sony introduced a direct-view model with a gigantic 43-inch tube and a \$43,000 price tag. But none of these models survived. Panasonic's Tom Edwards, assistant general manager for television, says his company's 51-inch rear projector was "too early and too expensive."

Another problem, says Philips' Smith, is that IDTV required a more holistic approach to TV design than was expected. The entire display system must be more sophisticated, since lines are being painted on the screen in between the standard lines. If the electron-beam spot size is too large, an IDTV set erases the line just before it. The result is a messy picture. "So it's not just the digital circuitry," Smith concludes. "It's a better display system, better CRTs, better power supplies, better everything."

A new generation of six IDTV models, including 31- and 35-inch direct-view models and 52- and 60-inch rear projectors, is now available from ProScan, the prestigious new brand name of Thomson. Why introduce IDTV now in light of other manufacturers' lack of success? Elliot Broadwin, Thomson's product manager for high-end color television, says the new IDTVs have been under development for several years. Thomson, which is also stressing wide-screen TV, is aiming for a leadership position in TV technology. Motion compensation has been given special attention to defeat motion artifacts.

Thomson initially planned on making ProScan IDTVs that could be up-

CONTROLS FOR DO-IT-YOURSELF CROPPING

From the dawn of cinema until 1953, when *The Robe* appeared in CinemaScope, most films were made in a standard 4-to-3 aspect ratio (width to height), or 1.33:1. After flirtations with CinemaScope's elongated 2.35:1 ratio and other formats, Hollywood has more recently settled on a handful of aspect ratios of less than 2:1. All the digital HDTV formats being weighed by the FCC have aspect ratios of 16 to 9, or 1.77:1. When Americans begin the slow shift to a wider screen, the familiar 4-to-3 world will change. TV programs and older movies produced in the old format will have to be banded at the sides or cropped at top and bottom to fit the new wider screens. Wide-screen programming—previously cropped at the sides, "letter-box" with bands at top and bottom, or squeezed via "anamorphic" lenses—will fit newer screens more comfortably, though deviations from the 16-to-9 standard may require cropping or banding. Here's a look at four scenarios that could be handled by a Sharp 36-inch wide-screen HDTV being marketed in Japan. Sharp's zoom control—expected to be a common feature on wide-screen sets in general—lets viewers adapt narrower or wider aspect ratios to its 16-to-9 screen by cropping the image or reframing it with bands.—M. F.



1. Standard 4 to 3 ratio on wide screen, with bands:

With the image at full height, blank bands fill out the sides of the screen. The screen is left partly empty but the image remains intact. Modern movie houses often use this technique to show older, narrower movies on newer, wider screens.



2. Standard 4 to 3 on wide screen, with cropping:

With images at full width, the top and bottom must be cropped. Many cinemaphiles howl in protest when theaters use this technique; others don't notice at all. On a Fred Astaire/Ginger Rogers dance routine, for example, you would cut off Fred and Ginger at the knee.



3. Letter-box format to wide screen:

Wide-screen programming banded for narrow screens can fill wider screens without cropping, assuming the original is exactly 16-to-9 (otherwise cropping or banding might be needed). A slight loss of resolution is possible as the viewer zooms in to eliminate the letter-box banding.



4. Squeezed wide screen to correct wide screen:

Film-conscious videophiles hate it when studios resort to the old "anamorphic squeeze," using optics to fit a wide image onto a narrow screen without cropping. This deliberate geometric distortion, which tends to make human figures look like something painted by El Greco, is often used with the opening credits of wide-screen movies to avoid loss of text. Then the anamorphic squeeze gives way to pan-and-scan cropping (shifting the viewpoint left or right). When a whole movie is squeezed, the wide-screen set can decompress it, restoring objects to their correct shape.



graded to a future digital-HDTV standard through an add-on converter. Further study of the proposed standards, however, eliminated that option. Some of the proposed standards, he says, would be incompatible with Thomson's IDTV tubes and scanning coils; expensive and complex decoding systems would also be needed. "We think IDTV technology can stand on its own because of what it can do with a standard NTSC picture," he adds. Regardless of which HDTV format is selected, NTSC pictures will be with us for a long time.

Wide-screen and IDTV television have already made their way into some home theaters, supported by an expanding supply of letter-box-format laser-disc and other sources. More than 400 titles are available, according to a wide-screen supplement to the Laser Video File catalog (Box 828, Westwood, N.J. 07675). More recently, high-end hardware that includes aspect-ratio controls has become available. The Vidikron VPH-40HD offers this feature with buttons located on the video projector. Runco offers a separate aspect-ratio controller, the \$3,995 model ARC-IV. Both techniques let viewers zoom in and out, manipulating and cropping the images on screens as they please (see Controls for Do-It-Yourself Cropping).

IDTV has become a premium image-enhancing option for big-screen front-projection TV. Why wait for HDTV, the reasoning goes, when you can have improved definition now by plugging in an outboard line-doubler or scan converter? Such devices—from Faroudja Laboratories, NEC, Runco, and Sony—work in concert with so-called multi-scan projection TVs such as Sony's \$20,000 VPH-1270, Vidikron's \$15,000 VPH-40HD, and Runco's combined projector and line-doubler. Capable of

handling varying scanning systems, including computer displays, these pricey projectors can also be adapted to HDTV.

NEC's \$4,335 IDC-1000 is one of the least costly approaches to outboard IDTV. This add-on has three composite (standard-video) inputs and one S-video input, which separates color and brightness. Like the Runco line-doubler, which NEC manufactures, the IDC-1000 uses so-called 3D motion adaptation. This technique enables the line-doubler to respond differently depending on whether the image contains motion. Generally, the more "adaptive" digital-TV circuits are, the better perpetually moving pictures will look.

Runco's Super-IDTV package includes both the SC 1050 line-doubler and IDC 800 multiscan projector for \$15,000. One defining feature of Runco's projector is that the color balance of its tubes match the original NTSC format specifications. That helps make black-and-white or Technicolor movies look their best.

Faroudja Laboratories' \$15,000 LD100 line-doubler is a top-of-the-line approach from inventor Yves Faroudja, who holds dozens of patents relating to video-signal processing. This unit evolved from Super NTSC, Faroudja's attempt to update NTSC without increasing the number of scanning lines. When the FCC indicated it would favor a digital high-definition format, Faroudja adapted his analog technology into this high-end line-doubler. In addition to the usual decoding and line-doubling, the LD100 also doubles the picture elements (pixels) in images, heightening both vertical and horizontal resolution.

Why is it so expensive? "Our position is to go full blast, make no compromise in terms of noise reduction, motion compensation, number of mem-

ories, and so forth," says Faroudja. Harnessed to the Vidikron projector, the Faroudja looks like the next best thing to true HDTV.

Curiously, IDTV is likely to find its way onto upcoming wide-screen HDTVs too. One reason is that a new HDTV standard will not sweep away the old television standard. Viewers will have to accept a certain percentage of programming in NTSC. Since the digital sophistication of HDTV makes IDTV easy to implement, NTSC-enhancing IDTV is likely to be a major feature of high-definition sets.

Says Faroudja: "If HDTV flies, it would be rational to use IDTV to process NTSC. You could simply change the programming of a given chip and operate with either an NTSC or HDTV input." Such flexibility would enable viewers to enjoy videotapes, laser discs, and broadcasts from small-market stations, which will probably be last to upgrade to HDTV broadcasting in line-doubled splendor.

That's not all. Even HDTV channels will use some line-doubled NTSC signals. If a small-town station captures a spectacular plane crash with NTSC equipment, the HDTV version of Cable News Network won't be able to ignore the event. The standard image will be line-doubled and sent over the HDTV channel, and most viewers will hardly notice the difference.

The introduction of expensive wide-screen and IDTV sets into stores before HDTV complicates buying decisions. "We are very concerned about confusing the consumer," says Dave Shoults, Toshiba's national sales promotion manager.

Even so, you better get used to seeing doubled lines in a wider picture. As Faroudja says, "This is the way TV's going to look eventually." ■

Wide-screen-TV models from Thomson Consumer Electronics, slated for introduction later this year, display 16-to-9 images with inputs from new wide-format camcorders, discs, or tapes, and occasional broadcasts of movies in letter-box format.



HIGH-TECH HARVEST

The first genetically engineered tomatoes may hit supermarket shelves next year. Other high-tech fruits and veggies are only a few years behind.

BY ROBERT LANGRETH

Growing in six small fields scattered across Florida and California are some extraordinary tomato plants. Not that you would ever know it by looking at them: Both the plants and the tomatoes themselves look like garden-variety crops.

The unique feature of these crops is hidden inside their DNA—the genetic “blueprint” that determines all their physical and chemical properties. In addition to the thousands of genes that make up the plants’ DNA, scientists have inserted a single gene not present naturally. The extra gene slows down a series of chemical reac-

tions that causes ripe vegetables to rot.

Most commercial tomatoes spoil so quickly that they must be picked while green and later artificially ripened with a chemical called ethylene, says William Hiatt, a researcher at Calgene Fresh, a subsidiary of Calgene, Inc., a biotechnology company in Davis, Calif., that is producing the new tomato. The result of forced ripening is flavorless fruit. In contrast, Calgene’s Flavr Savr tomato can stay on the vine a full week longer than regular tomatoes—allowing the necessary sugars and acids to develop—and still be shipped across the country. “Because it can go to color on the vine,” explains Hiatt, “it’s a better-tasting tomato.”

Next year, the company plans to

start selling the Flavr Savr to retailers. In all likelihood, it will be the first genetically engineered fruit or vegetable available to the public.

Calgene’s tomato, however, is just the beginning of what will be a many-splendored high-tech harvest. During the last decade, scientists have transplanted genes with all sorts of new traits into more than 50 different plants—from asparagus to sugar beets. Now, spurred by a U.S. government decision to streamline the regulation of genetically engineered foods, biotechnology companies

ILLUSTRATIONS BY MICHAEL WHITE





are rushing an array of these new crops to the market.

During the next several years, consumers will see "a steady flow" of high-tech produce, says Richard Godown, president of the Industrial Biotechnology Association based in Washington, D.C. Most of the initial products will be vegetables genetically engineered for resistance to pests, viruses, and blights that have dogged farmers for centuries. Agritech companies are also focusing on traits that will appeal to consumers. Some likely products: tomatoes that are bruise-resistant or freeze without becoming mushy when thawed; extranutritious potatoes; and vegetable oils with lower saturated fats.

Genetic engineering "will eventually enter the production of all our food crops," predicts Godown. "It's going to be pervasive. It's going to be worldwide. It's the single best hope of being able to feed all the people on the planet."

To live up to this grand vision, biotechnology will first have to overcome

its poor public image. Environmental groups, in particular, argue that directly tampering with plant genetic material poses unknown risks.

"Genetically engineering produce is [similar to] adding chemicals to food," says Rebecca Goldberg, a senior scientist at the Environmental Defense Fund. "Although most chemicals . . . have proven safe, every now and then something comes along that's not so safe. Think of some of the food dyes that have been taken off the market" because of cancer and other health risks.

To Goldberg's dismay, a new Food and Drug Administration (FDA) policy does not require government safety approval for most genetically engineered foods, as it does for food additives. Introduced in May, the policy lets companies perform their own safety testing and recommends they consult the FDA if they find anything unexpected.

Reflecting public fears, newspaper and magazine headlines have labeled genetically engineered produce "Frank-

enfood" and "Brave New Food" (referring to *Brave New World*, Aldous Huxley's novel about technology run amok). A recent *New Yorker* cartoon perhaps captured these misgivings best. It depicted a crazed scientist clenching his fists and cackling triumphantly at his giant-jawed plants: "There's splendid news from the FDA, my pretties!"

What many consumers probably don't realize is that farmers have been tampering *indirectly* with plant genes almost since the beginning of agriculture. Explains Ganesh Kishore, a plant researcher at the St. Louis-based Monsanto Co.: "Traditional plant breeding is not very different from [genetic engineering]. The end result of both is that people are reorganizing plant genes to introduce desirable properties."

Take crossbreeding. In many species, pollen from one plant fertilizes eggs from that same plant. In crossbreeding, pollen from one plant is used to fertilize a second plant to create a hybrid that combines the traits of both. For instance, one might try to mate a plant that produces large, bland strawberries with one that produces small, sweet berries, to get a fruit that's ideally both large and sweet.

This technique has produced hundreds of new crops, such as broccoflower, a hybrid of cauliflower and broccoli. But it's somewhat unpredictable, often resulting in unwanted traits along with the desired ones. Moreover, it works only with plants from the same or closely related species.

In 1973, for the first time, Stanford University biologists combined DNA from two unrelated organisms. Common to all living beings (except for some viruses), DNA is a long molecule shaped like a spiral staircase. Each "step" in the staircase is composed of one of four different chemicals called bases; the sequence of these chemicals determines what properties an organism will have. A gene, in fact, is simply a group of steps responsible for determining individual chemical components of cells. Genes are grouped into a fixed number of chromosomes (46 for humans, 20 for corn, for example), which are responsible for complex traits like color or size of an organism.

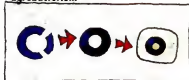
Like film editors splicing together sections of different videotapes, the Stanford scientists cut open a strand of bacterial DNA using a kind of chemical scissors called a restriction enzyme, then inserted a gene from a second, unrelated bacterium into the opening.

This accomplishment had enormous implications for plant breeders. At least in theory, scientists could now take genes from any organism, plant or animal, and add them to any other.

TWO WAYS TO BIOENGINEER PLANTS

AGROBACTERIUM METHOD

2. DNA is inserted into a larger ring of bacterial DNA (a plasmid), which is then absorbed into *agrobacterium*



3. *Agrobacterium* transfers DNA into plant cells



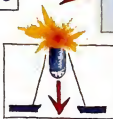
4. Plant cells divide



1. DNA with new properties

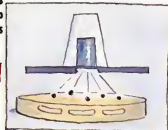


3. Particles are fired into plant cells



DNA PARTICLE GUN METHOD

2. Tiny metal particles are coated with DNA and put into a gun



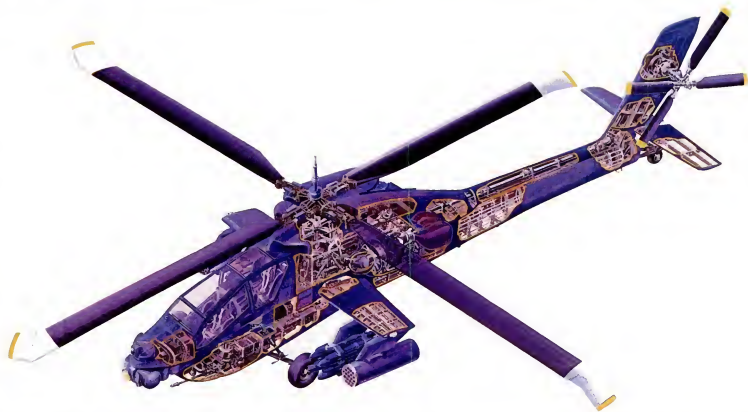
6. Plantlets are transferred to soil



5. Plant cells grow into plantlets on petri dish



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A potato plant (2) and cotton boll (3) genetically engineered for pest resistance are healthier than normal plants (1 and 4) grown in the same environment.

Furthermore, instead of adding hundreds of new genes in crossbreeding—some desirable and some not—scientists could add exactly the genes they needed.

In practice, however, plants proved more difficult to address than bacteria. Unlike bacterial DNA, plant DNA is protected by a thick cell wall. Since scientists didn't know how to insert materials through this wall without damaging the cell, they looked for a microbe that could carry new genes into the plants for them.

In the early 1980s, scientists from Monsanto and the Max Planck Institute in Cologne, Germany, showed that *agrobacterium*—a common type of bacterium that infects tomatoes, potatoes, and many other crops—does the trick quite effectively. Over millions of years of evolution, *agrobacterium* has learned how to penetrate cell walls and attach disease-causing genes to the plant's DNA. The research teams first removed these harmful genes from the bacteria, then replaced them with genes they wanted to add to the plant. Next, they mixed the altered bacteria together with plant cells and let the microbes do the rest.

It worked. And researchers had already figured out how to regenerate whole plants from individual plant cells. Thus, the race to develop genetically engineered foods was on.

The first fruits and vegetables of biotechnology will hit the supermarkets in three "waves," according to Robert Fraley, the head of agricultural research at Monsanto, which is developing several high-tech vegetables. Calgene's tomato being the exception, the first wave of gene-spliced produce will be mostly pest- and disease-resistant crops.

Monsanto and several other companies, for instance, have added genes from the caterpillar-attacking bacteria *Bacillus thuringiensis* into cotton, tomato, and potato plants. Once inside

the plants, the genes produce proteins that kill crop-eating caterpillar larvae, but are harmless to other animals and plants. Other companies have added new genes to cantaloupe, squash, and potato plants to make them resistant to deadly viruses. In yet a third development, Monsanto and others have genetically altered cotton plants to make them tolerant to glyphosate, an environmentally safe weed killer. (Many environmentalists, however, complain that such crops would promote chemical use over organic farming. Some worry that insects could eventually become resistant to the pest-proof plants, resulting in widespread crop failures. Conversely, others speculate that high-tech crops could cause an agricultural Midas plague: man-made plants so successful that they crowd out naturally occurring foliage.)

Within five years, more than a dozen pest- and pestilence-proof crops could hit the marketplace, say industry leaders. In Third World countries, insect-re-

pellling vegetables could help alleviate serious food shortages. "Conventional agricultural techniques will not provide the more than doubling of food output that the world will need" in the next 40 years, argues Fraley. "Genetically modified crops are one key" to doing so.

In the more affluent United States, bug- and virus-proof crops "are going to be a tremendously positive step toward making agriculture more environmentally friendly," Fraley says. Besides reducing pesticide use up to 60 percent for some crops, he notes, these crops may make it possible for farmers to plow their fields less often, slowing soil erosion. Currently, farmers must till their soil often to get rid of weeds and bugs.

"Coming quickly on the heels of [insect- and virus-resistant crops] are bio-engineered vegetables that are targeted toward food processors or provide unique consumer traits," says Fraley. Much of this second wave of products will involve tomatoes, for two reasons:

(Continued on page 122)

BIOTECHNOLOGY: A THIRD-WORLD SAVIOR?

For the last ten years, researchers have hailed genetic engineering as a technology that will reduce hunger and poverty in developing countries. Starting about a year from now in Mexico, they will get their first chance to prove it.

The Mexican government, using seeds and expert assistance donated by St. Louis-based Monsanto Co., is adapting the company's virus-resistant potato plant for Mexican varieties of spuds. By the beginning of 1994, Mexico plans to start providing farmers with seeds for these plants.

Every year, between 10 and 60 percent of Mexico's potato harvest is destroyed by insect-borne viruses, according to Luis Herrera-Estrella, a Mexican researcher who is coordinating the project. For small farmers who can't afford pesticides, the virus can wipe out entire crops.

"For many farmers, this genetically engineered plant could mean survival," Herrera-Estrella says. Overall, "the project could re-

duce crop losses in Mexico by 15 percent."

Strangely enough, the source of the virus resistance turns out to be the virus itself. To reproduce, the potato virus must first remove a chemical "coating" that normally covers it. The genetically engineered potato plants, however, contain the viral genes that allow them to make this coat. "Every time the virus gets ready for sex by taking off its coat," the plant simply covers it with another coat, says Herrera-Estrella. Even after a month of constant exposure to the virus, the plants are hardly affected.

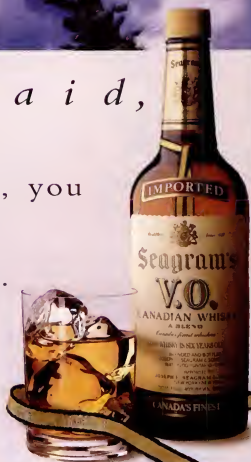
Monsanto is also collaborating with Kenya and other African countries on similar projects. In giving away its technology, however, the biotech giant isn't simply exhibiting corporate altruism. Besides generating some rare positive publicity, says Monsanto research chief Robert Fraley, the company hopes that gene-altered vegetables may someday make Third World farmers rich enough to become paying customers.—R. L.



*S*omeone once s a i d,

"If you could *b o t t l e* that, you
could *s e l l* it." So we *d i d*.

V.O.



The Smooth Taste of Canada's Finest



WHEN THE GOING GETS TOUGH

BY JIM McCRAW

Is the new generation of sport utilities becoming a bunch of suburban dilettantes? We test the newest in ice, snow, and on the highway to see if the technology really works in all dimensions.

CHEVROLET SUBURBAN

GMC JIMMY

ISUZU TROOPER

JEEP GRAND CHEROKEE

MINI COOPER

Though today's designer sport-utility vehicles have their roots in the mud and the military, they are mainly used not for off-roading, not for exploration, but for getting to work and school in crummy weather conditions—a long way from "sport" and a lot closer to "utility." Still, the peace of mind that comes with complex four-wheel-drive systems, antilock brakes, high ground clearance, and the rest of the technological overkill designed to walk over rocks and fallen trees is as much a part of the appeal of the new generation of sport-utility vehicles (SUVs) as the boxy styling reeking of outdoorsiness.

Sport utilities with suburban aspirations have been gaining in popularity in recent years, faster than any other vehicle type. Today's SUVs are repositories of a bewildering variety of mechanical and electronic systems aimed at enhancing traction and/or convenience. This year, a burst of activity has brought us a number of new models that deserve evaluation. Jeep, a long-time leader in the four-door SUV field, has introduced a brand new design for 1993—the Grand Cherokee—which Chrysler hopes will counteract the sales home-run of the Ford Explorer ("What

Goes in the Snow?" Oct. '91). Joining it are radically redesigned Japanese stalwarts: the new Isuzu Trooper and Mitsubishi Montero. And even GMC's venerable Jimmy—a year away from a new chassis and body—has had significant technical upgrades. Chevrolet completely redesigned the Suburban for 1992, basing it on the considerably more refined C/K truck chassis. With the optional 7.4-liter V8, it's hardly in the same class as the other four SUVs, but we pressed it through the same tests and relied on it as a cargo-hauler. Its bulk hindered performance in our track tests, but its overall agility proved a surprise.

At first glance, running a group like this through traditional performance tests has the flavor of running a draft horse at Belmont, but sport utilities as a group have often suffered from high-speed handling flaws, and any quirks showed up quickly in our handling regime. Still, the ability to go when it snows is essential, and to test this

group in its primary element, we trekked northward to a winter test track in Racine, Mich., near the Canadian border. The track is operated by ITT Teves—a company noted for its development work in antilock brakes and traction control systems. This environment of dry-track, high-speed testing in combination with snow-and-ice-bound handling courses was laden with extremely slippery challenges. As it turned out, not one of the vehicles managed to overcome all of them.

The rigors we encountered in a few days easily equaled what most drivers would see in a lifetime. This broad range of conditions, though, demonstrates the difficulty of developing a vehicle that's not only responsive on- and off-road, but is capable of the same service as a station wagon. The two poles pull in opposite directions, and clearly the trend today favors the carlike characteristics.

Jeep's all-new Grand Cherokee Limited is a good example. It is the only SUV today in its class that forsakes pickup-based straight frame rails and uses unit-body construction normally associated with passenger cars. This allows the floor pan to nestle low, cutting overall height while retaining ground clearance. While its critics argue that unit bodies may not be quite



While three of the SUVs could be provoked to lift two wheels in the lane change, the Isuzu Trooper (top) would do it at test speeds less than 50 mph and with far less severe steering input than the Jeep Grand Cherokee (middle) and the Mitsubishi Montero (bottom). The GMC Jimmy was flat and relatively slow in the same maneuver.

as durable as a frame-and-body assembly, they are generally regarded as stiffer and quieter. The main change in the new Jeep that affects its ride and handling is a new coil-spring rear-axle assembly, replacing the old leaf springs—a change likewise aimed at improving ride, but not hurting ground clearance or traction.

The Grand Cherokee series comes in base, Laredo, and Limited models—the Limited being our test unit. Jeep offers an unusual and confusing combination of drive systems: part-time CommandTrac in the base Cherokee, shiftable full-time SelecTrac in the Laredo, and all-the-time QuadraTrac in the Limited only. CommandTrac is a

conventional transfer case that is engaged manually and couples the front and rear axles directly. SelecTrac and QuadraTrac feature a center differential that allows full-time four-wheel-drive operation. The QuadraTrac system is essentially a full-time four-wheel-drive system incorporating a viscous clutch that splits torque to the front and rear—similar to several passenger-car setups but with a low-range gearbox for serious off-roading.

The Cherokee also is one of the few remaining vehicles in this class to use an in-line six-cylinder, rather than the V6s and the Suburban's V8 in the remainder of our fleet. The four-liter 190-hp straight-six engine is offered with either a five-speed manual or four-speed automatic overdrive transmission (standard in the Limited).

The Grand Cherokee's 105.9-inch wheelbase is 4.5 inches longer than the original Cherokee's, and it is 7.7 inches longer overall, at 176.5 inches. There's also more front and rear hip room, and front shoulder room—substantial gains in the SUV space race.

The Grand Cherokee is rife with carlike features, including a driver-side air bag, standard four-wheel ABS, a thermometer/compass on the roof console, and doors that open all the way into the roof panel.

Mitsubishi's new Montero SR looks like it should be blasting across the Serengeti Plain. Part of the reason is that it is one of the biggest and the tallest of the group, set up in the air on six-lug wheels and truck-type tires. The new Montero is 10.1 inches longer than the Grand Cherokee and almost 1.5 inches longer in wheelbase, yielding a substantial 96.6 cubic feet of interior space with the seats down, 44.8 with the seats up. The two-tone paint treatment seems to deliberately accentuate the size and shape of the tires, adding to the go-anywhere appeal of the Montero ("mountain man" in Spanish). The Montero has no brush bars, roof rack, or driving lights to spoil the shape.

Mitsubishi's three-liter single-overhead-cam V6 engine makes only 151 hp at 5,000 rpm, but sounds better doing it than the Jeep in-line six, the Jimmy V6, or the Isuzu V6—which is the loudest during acceleration. The engine works hard all the time because of the Montero's weight and acceleration drag, and it returns about 15 mpg. (The others in this group are EPA-rated only slightly better for fuel mileage; SUVs are clearly not economy cars.)

The Mitsubishi Active Trac four-wheel-drive system, which incorporates four-wheel multimode ABS in ei-

ACCELERATION



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(M)



The long-wheel-base Chevrolet Suburban (left) is easier to control while sliding on loose snow than the short-wheel-base GMC Jimmy (far left).

tem improved ride quality in this tall, softly sprung machine, optimizing its slow off-pavement performance and high-speed, dry-road dynamics.

Isuzu, though not as big as giant Mitsubishi, has an enviable reputation for the quality and durability of its trucks, which are sold all over the world. The Trooper LS test vehicle is a truck, through and through, in its clean functionality and presence, but that doesn't mean the interior is a bare-metal echo chamber.

The Trooper was the only one in the group to have a 70/30 rear-door setup, in which 70 percent of the door opens on the left where the spare tire is mounted and 30 percent opens on the right for access to the rear compartment. The vertical seams in the rear window glass to accommodate this design obstruct rearview-mirror vision.

And this truck, oddly enough, doesn't have a typical truck engine either. The 190-hp four-cam 24-valve V6 tied with the Jeep as the most powerful engine in this group. (A single-overhead-cam four-valve, rated at 175 hp, is available in the S model.)

The Trooper also has a relatively

crude part-time four-wheel-drive system, though it deserves credit for simplicity of operation and dry-pavement fuel economy. The automatic transmission offers alternative shift program selections via two additional console buttons: winter mode and power drive. The winter mode, intended to lessen the chance of losing traction by starting in third gear, was of very little help in getting the Trooper moving. Because it switches off after every use, this mode proved annoying for a convenience item. Power drive is for towing, allowing the transmission to stay in each gear longer before upshifting.

The Trooper is a big sport utility artfully placed inside a small body shell (51 cubic feet with the seats up, 90 cubic feet with seats down). It gives a comfortable, soft ride on or off the pavement, with upper and lower arms and torsion bars up front, a four-link coil-spring rear suspension, and Goodyear Wrangler AP 245/70R-16 tires. The 70/30 rear doors have certain advantages, but overall we would prefer a single, large left-hinged door for both utility and greater outward vision.

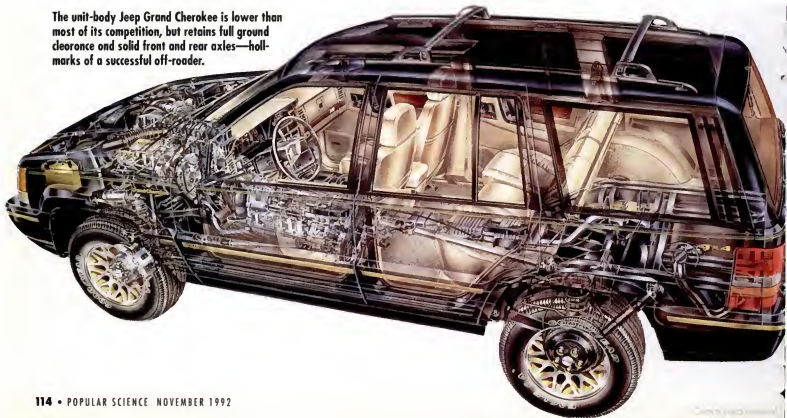
Of this group, the GMC Jimmy re-

ally is a compact sport utility. It is small, riding on a mere 107-inch wheelbase, with a length of about 177 inches overall. There's not a lot of passenger/storage room inside, either—only 67 cubic feet of space with the seats down and 28 cubic feet with the seats up. In the face of these three fresh competitors, the Jimmy is the oldest vehicle in the group and suffers by comparison to the newer technology (but not concerning the bottom line).

GMC's Jimmy is powered by a 90-degree, 4.3-liter, push-rod V6 truck engine that makes 160 hp at 4,000 rpm, and a lot of noise and vibration through its rev range. The new optional L35 high-output, 4.3-liter V6 engine, which we could not obtain for this test, has a balance shaft, central port injection, and makes an additional 30 hp, an option choice that we would recommend to any Jimmy buyer.

A true north-woods resident could have written the rest of this story, about how the greenhorns from down south went off in the snow with their shiny new designer sport utilities and promptly got stuck. Not

The unit-body Jeep Grand Cherokee is lower than most of its competition, but retains full ground clearance and solid front and rear axles—hallmarks of a successful off-roader.





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THE 1993 MAZDA RX-7

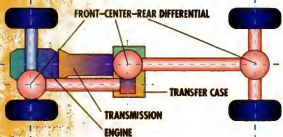
Sequential twin turbo rotary engine. Independent double-wishbone suspension. 11.6-inch, ventilated four-wheel disc brakes with ABS. Driver's-side air bag. 36-month/50,000-mile, no-deductible, "bumper-to-bumper" warranty. 24-hour roadside assistance. See your Mazda Dealer for limited-warranty details. To receive a free RX-7 brochure, call 1-800-639-1000.

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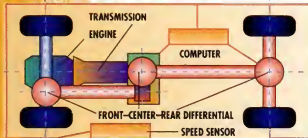
FIVE DIFFERENT FORMS OF FOUR-WHEEL DRIVE

FULL-TIME 4WD SYSTEM



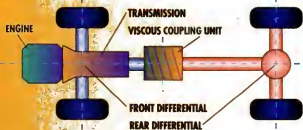
Full-time four-wheel drive is rare on SUVs, but two versions are offered for the Jeep Grand Cherokee. The center differential accommodates speed differences between the two axles, necessary for on-highway operation. The Montero is also essentially a full-time system.

INTEGRATED FULL-TIME 4WD SYSTEM



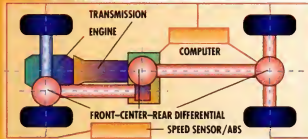
Computer control enhances a full-time system, adjusting the torque split depending on which wheels have traction. Subaru and Ford Aerostar vans use this system.

ON-DEMAND 4WD SYSTEM



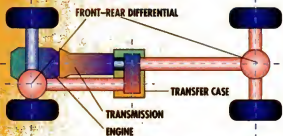
On-demand four-wheel drive powers a second axle only after the first begins to slip. It's used by Volkswagen for the automaker's four-wheel-drive van and is useful mainly for getting out of a slippery spot rather than serious off-roading.

ANTILOCK BRAKES AND TRACTION CONTROL



Antilock brakes and traction control are relatively new for SUVs, although all of our test cars featured antilock brakes. So far, electronic traction control is in the experimental stage for SUVs, which instead rely on deep-tread tires, limited-slip differentials, and all-wheel drive.

PART-TIME 4WD SYSTEM



Part-time four-wheel drive is rugged and time-honored. The Jimmy, Suburban, and Trooper were so equipped, although the Trooper enhanced this system with a special automatic transmission mode that starts in third gear in the snow. The main drawback is the necessity to shift it manually.

exactly. But overconfidence is the name of the game when you first eye those deep-tread tires and anticipate all that four-wheel-drive traction.

We first noted a surprising lack of difference in four-wheel-drive, 0-to-40-mph snow acceleration performance from our five stalwarts, all in a tight group between seven and eight seconds. None of the sport utilities did a great job accelerating on the split-mu test surfaces (a surface with different coefficients of traction for each side of the vehicle—in this case, clean, dry pavement on the left, ice on the right). This was because only the Suburban has a limited-slip differential that functioned with real effectiveness, though all were so equipped. The Jeep had the best times, but it was eclipsed on split-mu acceleration by the gargantuan Chevrolet Suburban 454 V8 4x4.

Similarly, when we parked each vehicle on both 10 and 20 percent split-mu grades, with ice under one tire and dry pavement under the other, and tried very carefully to get them up and over the grade from a dead stop, we had more mixed results. The Trooper wouldn't make either grade. (It was discovered in a post-testing inspection that its limited-slip unit had failed.) The Mitsubishi likewise barely squeaked up the grades by feathering the throttle, as did the Jeep. The Jimmy made the 10 percent, but not the 20 percent grade. The Suburban went up both grades effortlessly.

The reason for this mediocre performance is the action of a clutch-type limited-slip differential, the most common option where so-called limited-slip differentials are specified. The torque available across the clutch discs is limited—insufficient to pull the vehicles up a mild grade with one wheel on ice. It is an old bugaboo for alleged four-wheel drive that actually sends power to only two wheels at certain times. An alternative is the full-locking-type limited slip, favored by General Motors for its huge Suburban, which uses a pawl action to positively lock the differential, then opens it via centrifugal action at road speeds. On the steep split-traction grade, the action smoked the tires on the dry surface as it walked up the grade easily.

Every vehicle earned high points for braking stability. GM finally has installed full four-wheel ABS in its S-10 based utilities—replacing a decidedly inadequate two-wheel system that was disengaged when the vehicle was put in four-wheel drive. The others likewise have four-wheel antilock systems.

We brake-tested the fleet on a combination of ice and dry pavement, consis-

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tent fresh snow, and on a dry track, all from 40 mph. The Mitsubishi Montero did the best overall job with its combination of four-wheel drive and four-wheel ABS, the Isuzu with optional ABS was next, the ABS-standard Jeep third, the ABS-standard Jimmy next, and the Suburban a distant fifth, over a best-to-worst spread of 90 feet.

Handling on the big, snow-covered circle again proved the superiority of a longer wheelbase to add stability and increase the chances of making corrections after a slide began. The Jimmy suffered mildly in this respect, and the Trooper and Jeep shared the ability to slide under road-rallylike control.

Finished with the snow, we headed south to our regular dry-track test site, where we encountered our most severe problems in the double-lane change. In this test, the Montero performed marginally, the Isuzu Trooper, unacceptably.

The double-lane change roughly duplicates a vehicle swerving to avoid an obstacle in a high-speed emergency maneuver, where suspension shortcomings can cause loss of control. POPULAR SCIENCE is one of few magazines doing road tests that routinely performs this maneuver, which occasionally results in tail-wagging and loss of control, but rarely a tendency to actually lift wheels en route to a rollover. SUVs as a group

[Continued on page 120]

LONG ON CHARACTER

The deft steering, reasonable ride, and low stance of the new Jeep Grand Cherokee set it apart from virtually all other sport utilities, in a direction that should satisfy anybody but the hardcore off-road set. The new styling is fresh, modern, and retains the aura of Jeep that is as identifiable as a pair of blue jeans in American lore. If there is any flaw in the Grand Cherokee it is in the execution, not the concept. I would push for more refined controls to match its upscale image. Though not the roomiest or most luxurious in its class, it has the best all-around character.

Given the strength of interest in sport utilities, particularly those with four doors, the GM compact Jimmy and S-10 Blazers have been stalwarts, but lagging in development. Late with a four-door and now last to do a complete revamping, the vehicles are a bit dated, albeit solid and predictable with a high-torque power plant.

The Trooper and Montero are in the luxury-utility category, loaded with features and arguably smoother and more refined than the Grand Cherokee. The boulevard ride is gained at an unacceptable level of handling compromise, however, and both of these utilities need work.—Dan McCosh

POPULAR SCIENCE TEST RESULTS

CHEVROLET SUBURBAN K2500

GMC JIMMY

ISUZU TROOPER LS

JEOP GRAND CHEROKEE LIMITED

MITSUBISHI MONTERO SR

ACCELERATION & HANDLING

0-30 mph (sec.)	4.0	3.2	3.7	3.5	3.5
0-40 mph (sec.)	12.9	9.5	11.1	11.1	10.8
30-50 mph (sec.)	6.0	4.3	5.4	4.9	4.7
50-70 mph (sec.)	9.2	6.0	7.2	6.8	7.2
Double-lane change (mph)	52.0	54.0	48.8	51.4	45.6
Slalom (mph)	40.4	46.3	39.8	42.3	37.7
Road-holding (g)	0.70	0.78	0.71	0.70	0.67

BRAKING

Cold (ft.)	148	140	156	176	166
Warm (ft.)	150	137	145	169	162
Hot (ft.)	161	144	149	169	162

INTERIOR NOISE

Idle (dB)	44	51	46	46	56
60 mph (dB)	70	70	68	69	67
0-40 mph (dB)	76	79	81	79	74

WINTER TESTS

Acceleration 0-40 mph					
Ice/dry 2WD/4WD (sec.)	30/17 (locked)	/14	25/22	/23	7/7
Snow 2WD/4WD (sec.)	14/8	/7	19/7	17/8	9/7
Braking 40-0 mph					
Ice/dry (ft.)	150	170	160	170	240
Snow (ft.)	160	150	160	190	200

SPECIFICATIONS

POWER TRAIN

Engine	3.0L V6	4.0L V6	3.2L V6	4.3L V6	7.4L V8
Valve train	SOHC, 2 valves/cyl.	Push rods, 2 valves/cyl.	DOHC, 4 valves/cyl.	Push rods, 2 valves/cyl.	Push rods, 2 valves/cyl.
Power (hp @ rpm)	151@4,500	190@4,750	196@5,600	160@4,000	230@3,600
Torque (lb. ft. @ rpm)	174@4,000	225@3,000	195@3,600	230@2,600	395@1,600
Compression ratio	8.9:1	8.8:1	9.8:1	9.3:1	7.9:1

Transmission	4-speed automatic	4-speed automatic	4-speed automatic	4-speed automatic	4-speed automatic
Final drive ratio	4.88:1	3.55:1	3.42:1	3.42:1	3.27:1

CHASSIS

Front suspension	Independent, unequal-length control arms, torsion bars, anti-roll bar	Rigid axle located by four leading links and a panhard rod, coil springs, anti-roll bar	Independent, unequal-length control arms, torsion bars, anti-roll bar	Independent, unequal-length control arms, torsion bars, anti-roll bar	Independent, unequal-length control arms, torsion bars, anti-roll bar
Rear suspension	Rigid axle, two trailing arms, panhard rod, coil springs, anti-roll bar	Rigid axle located by four trailing links and a panhard rod, coil springs, anti-roll bar	Rigid axle located by three trailing and one lateral member, coil springs, anti-roll bar	Rigid axle, semi-elliptic leaf springs	Rigid axle, semi-elliptic leaf springs
Steering gear	Recirculating ball with power assist	Recirculating ball with power assist	Recirculating ball with power assist	Recirculating ball with power assist	Recirculating ball with power assist
Turning circle (ft.)	38.7	36.6	38.1	35.4	46.4
Brakes (front, rear)	ABS; vented disc, disc with power assist	ABS; vented disc, drum with power assist	ABS; vented disc, vented disc with power assist	ABS; vented disc, drum with power assist	ABS; vented disc, drum with power assist

EPA MILEAGE

City	15	15	15	16	N.A.
Highway	18	20	18	21	N.A.

DIMENSIONS

Wheelbase (in.)	107.3	105.9	108.7	107.0	131.5
Length (in.)	186.6	176.5	178.9	176.8	219.5
Width (in.)	70.3	69.3	68.7	65.4	77.0
Height (in.)	74.8	64.7	72.8	64.3	74.9
Curb weight (lbs.)	4,493	3,531	4,248	3,900	6,490
Distribution (% front/rear)	55/44	56/44	52/48	53/47	52/48
Fuel tank (gal.)	24.3	23.0	22.5	20.0	42.0
Interior volume (cu. ft.)	101.4	98.7	105.4	97.4	156.0
Trunk volume (cu. ft.)	64.8	40.0	46.3	35.2	50.6

PRICES, PARTS, AND LABOR

Base price	\$22,429	\$27,433	\$25,400	\$17,451	\$21,559
Price as tested	\$27,490	\$27,433	\$27,050	\$21,574	\$29,780

REPAIR: PARTS/LABOR*

Front brake pads	\$48/43	\$ 80/34	\$104/30	\$190/35	\$44/94
Front shock/strut	33/31	33/13	75/20	42/19	22/19
Alternator	250/26	260/26	332/23	145/19	163/19
Water pump	84/122	112/53	110/77	108/27	83/53
Windshield	390/135	180/79	534/90	178/35	428/110
Headlamp assembly	91/17	78/13	180/38	72/8	90/19

*Labor costs reflect manufacturer's flat-rate time allowance multiplied by typical dealership labor rates per hour. †Split-mu surface.



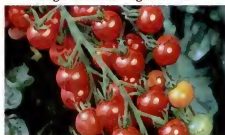
1 Viva Italia Hybrid. Tastes great fresh and in sauces. Unusually high in natural sugars.



2 Big Girl® Hybrid VF. Sweet. Many over 1 lb. make it perfect for slicing or wedges.



3 Supersteak Hybrid VFN. Extra-meaty. Most weigh 1-2 lbs. Tolerant to disease.



4 Super Sweet 100 Hybrid. Amazingly sweet. Extremely productive over a long season.



5 Early Girl Hybrid. Sweet yet tart. Produces fruit early and often.



6 Delicious. It's seed grew the world's largest tomato! Excellent flavor.



7 Long-Keeper. Best-storing tomato we've seen—keeps for up to 5 months! Burpee bred.



8 Roma VF. Recommended for sauces and catsup. Also great for canning.



9 Gardener's Delight. Rich and abundant. An old time favorite.



10 Pixie Hybrid II. Ideal for growing in pots, our fastest-ripening tomato.



11 Yellow Pear. Mild and pleasing for salads, preserves or pickling.



12 Celebrity Hybrid. All-America Winner. Tolerant to many diseases.

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BURPEE®



Tough-going in 4X4s

(Continued from page 118)

are statistically more prone to rollover than most other types of vehicles—a subject of considerable controversy in engineering circles, as well as several class-action lawsuits.

The usual explanation is that the high center of gravity needed to attain good ground clearance is to blame, but in reality many pickups and vans are at least as high as SUVs. A better explanation is offered by research conducted by Daniel Metz at the University of Illinois that indicates a slow, natural roll frequency combined with a lane-change-type maneuver can roll over virtually any vehicle under certain conditions.

While we kept all the vehicles on their feet, the Trooper picked up two wheels easily at a low 45-mph-plus speed in our lane-change tests, and we later witnessed one simply topple over at relatively low speed in a slalom event at a press conference. The soft springs contribute to an extreme body lean that is considerably aggravated by violent maneuvers. The Montero, likewise softly sprung, easily lifted two wheels, and sometimes jumped and hopped with the adjustable shocks in

the "soft" mode, but improved dramatically in the "hard" mode. Obviously, the lane-change at high speed is a violent maneuver beyond the realm of normal driving, but these two vehicles rank among the least stable we have tested.

Wheel lift alone is inconclusive, however. The Grand Cherokee was fastest through the lane change, feeling aggressive and controllable, despite air showing under two wheels at times. The GMC Jimmy stayed on all fours, although it was slightly slower than the Montero through the cones.

In this winter testing context, the GMC Jimmy wasn't fighting unarmed, but it was down to a handful of bullets. Its handling and balance are good, and it's quick off the mark. The Jimmy is simple, effective, and inexpensive, but it is an old vehicle design that's within a year or so of retirement. The Jimmy is crudely finished, and too cramped to compete effectively with the later generation of vehicles, feeling like it could use about a hundred pounds more structure just to hold itself together.

The ABS and Uniroyal Laredo tire combination on the Jimmy turned in

consistently long stopping distances in every test—dry, ice, or snow. Also, the interior had some quality fit and finish problems, and the spare tire rack rattled relentlessly—mainly because it was difficult to latch completely. To its credit, the relatively light 3,900-pound Jimmy, with its torsion-bar and leaf-spring suspension, was the only contender among the compact SUVs that did not get up on two wheels during the triple-lane-change test. For those on a budget, the GMC Jimmy should certainly be considered, with its all-up price some \$6,000 to \$8,000 cheaper than the other four sticker prices. Make sure to get the optional engine.

Suburban life

If you ever wanted to drive a school bus at LeMans, the new Suburban ought to be your first choice. Adjectives like huge, hulking, and monstrous came to mind at our first encounter with the new C/K-platform-based Suburban. But when we put the Suburban through handling exercises where its wheelbase seemed to take up all the space between the cones, the steering was light, and corrections were easy.

Independent research shows:

NordicTrack® preferred six to one over ordinary exercisers.

In 1988, Burke Marketing Research conducted a survey among NordicTrack owners who also own exercise bicycles and hydraulic cylinder rowers. Their findings showed that by a margin of 6 to 1, respondents prefer their NordicTracks.

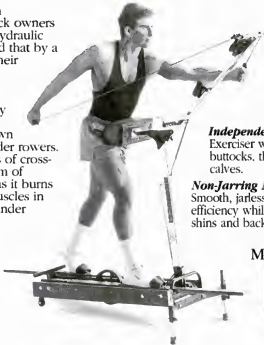
They have several good reasons. NordicTrack's upright position is more absorbing and fun, both mentally and physically, and provides greater freedom of movement than the sit-down positions of bikes and hydraulic cylinder rowers.

NordicTrack simulates the motions of cross-country skiing—the most effective form of aerobic exercise known—which means it burns more calories and conditions more muscles in less time than bikes and hydraulic cylinder rowers.

All of which means that owners have found that they can achieve their fitness goals more quickly and easily with NordicTrack than with bikes and hydraulic cylinder rowers, and without risk of injury.

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Patented flywheel and one-way clutch mechanisms provide continuity of motion, making exercise more pleasant and easier to sustain.



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Upper-body exerciser works extensor muscles of the back, trunk rotators, biceps, triceps, shoulders, chest and upper back.

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Comfortable upright position is more natural, more stimulating and allows greater freedom of movement.

Independently Adjustable Lower-Body Exerciser

Exerciser works hip flexors, gluteus muscles of the buttocks, thighs, hamstrings, knee extensors, ankles and calves.

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The straightforward four-wheel drive, fully locking differential, and elephantine ground clearance made it seemingly impossible to get stuck (nonetheless, we managed). The old Suburban was loaded with character, utility, and squeaks and rattles. This new one is sleek, smooth, and almost carlike in its manners.

The Suburban's trailer-towing capacities are legendary, and we never got quite used to that last row of seats way back there. Thanks to the 42-gallon gas tank, the gauge dropped slowly, but prodigious fuel consumption forced us to dip deeply into our bank account. A turbodiesel is in the plans for the future, and that should relieve some of the financial strain.

The Trooper redesign is a truck made comfortable and capable by a smooth, powerful engine and a thousand details. It is a very simple vehicle that sails down the road with confidence. So is the powertrain a success, a lovely four-cam, four-valve engine with lots of grunt and a well-matched transmission, part-time differential, and gearing. Its overall performance is solid, and its handling feel is a bit ponder-

ous. The Trooper is a big, comfortable, heavy, and expensive SUV. We think it should perform much better off the road at these prices, since its capability on slippery surfaces is what most buyers are looking for in this class.

Of the smaller vehicles in this test, the Mitsubishi Montero SR gets special recognition for family use and high marks for its simple style. The Montero has that wonderful can-do feel about it, and it was perfectly comfortable at very high speeds on the one-mile circular snow track. It is underpowered for acceleration, but not for slogging, because of the engine's low-speed torque output. Like so many vehicles under severe scrutiny, it didn't win any test honors (except quietest idle at 44 decibels), but it won a high place for its all-around good performance, size, and features. As pricey as the Isuzu at about \$27,000, the Montero packs a lot of neat features for the money.

Class of the field

In ice/dry split conditions, in snow, and in dry conditions, the Jeep's performance was in a class by itself, the sportiest handler of the bunch. Because

of its power, its Goodyear GA street performance tires, its low center of gravity, and chassis tuning aimed at street and highway ride, the Jeep made the other three pale. It won the acceleration derby outright, along with the dry braking tests, the skid pad, the slalom, and the double-lane change, a dominant performance, to say the least.

But the Jeep does have a few flaws, chief among them is that it's small inside for family use and storage needs. The engine is noisy and rough at high rpm. The gated drive selector lever takes too much effort, and some of the other controls and switches are clunky. When we decided after a morning of careful testing to have an impromptu bash-through-fresh-snow test, it was the first, but not the last, of the four to get stuck. In the double-lane-change test, it sometimes lifted two wheels, albeit at a higher speed than the Trooper and the Montero. Nonetheless, the Jeep Grand Cherokee is a very well-executed SUV and deserves high marks for its carlike safety equipment, comfort features, and behavior, at a price very close to a similarly loaded Montero SR or a Trooper LS.

Amazing results:

After five years, 7 out of 10 NordicTrack® owners still use their machines more than 3 times per week.

The most effective aerobic exercise machine on the market.

In 1988, Maritz Marketing Research conducted a survey among NordicTrack owners who had owned their machines for more than five years. The study found that 69% of respondents still use their machines an average of 3.5 sessions per week, 25 minutes per session.

The reason is simple. Users find that NordicTrack not only exercises more muscles and burns more calories in less time than other machines, but that it's more stimulating and enjoyable as well.

Cross-country skiing — the best aerobic exercise.

NordicTrack duplicates the motion of cross-country skiing, which experts agree is the best form of aerobic exercise. Better than biking, hydraulic cylinder rowing, running or swimming.

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Doctors and nutritionists know that diet and nutrition play an important role in maintaining good health. They recommend eating more fruits and vegetables.

One of the best ways to add fruits and vegetables to your diet is by juicing. I've been juicing fruits and vegetables for more than 40 years, and I believe fresh juice is the source of my continuing, extraordinary good health and vitality.

Both the National Cancer Institute and the American Cancer Society recommend daily consumption of foods rich in beta-carotene.

You've probably heard of a substance called *beta-carotene*. It's a precursor to Vitamin A found in dark leafy greens, and yellow fruits and vegetables. Carrots and citrus, along with kale, brussels sprouts, broccoli, and other cruciferous vegetables are carotene-rich, and also packed with Vitamin C.

Many scientists believe these vegetables help the body inhibit numerous types of tumors and cancers, including breast cancer.

Recent studies have demonstrated the more beta-carotene you consume, the lower your risk for cancer. An excellent way to get substantial amounts of beta-carotene in your diet each day is by drinking a tall glass of fresh carrot juice. And it's a whole lot easier than munching on several pounds of raw carrots every day!



Jay Kordich is known to millions as "The Juiceman." Author of the best-selling book, *The Juiceman's Power of Juicing*. Jay travels the country lecturing on the benefits of drinking fresh, raw vegetable and fruit juices.

A natural way to help control high blood pressure and joint pain?

Many fresh fruit and vegetable juices are rich in potassium and calcium, but low in sodium. So they are a perfect way to help maintain your blood pressure naturally. A diet

Food or Medicine?



high in potassium and calcium, and low in sodium, has been shown for many people to be an effective aid in preventing high blood pressure.

In addition, many people suffering from joint inflammation find they get relief from drinking fresh pineapple juice. This is because pineapple juice is loaded with an enzyme called *bromelain*, which was discovered in the 1950's to have a powerful effect in reducing inflammation.

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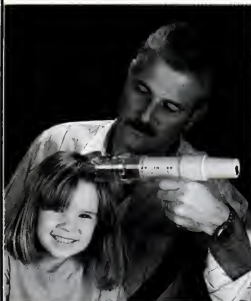
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Interactive TV

(Continued from page 95)

of each movie and staggered starting times, the average delay for any film is about ten minutes. ICTV's system would provide previews, reviews, ordering, time-slot choice, VCR taping options—even a simulated theater lobby where you can play video games before the movie begins. David Serlin calls it "the ultimate impulse pay-per-view. You watch the trailers, point at the screen, make a choice, and get the movie," he says.

Need help? A button on ICTV's remote introduces an animated help agent, a Mr. Magoo-like next-door-neighbor who comes over and helps you start your lawn mower. "This is a TV—not a computer," says Serlin. "We don't want you to read manuals or make you feel foolish that you don't understand how to use everything."

Learning your tastes

There are also shopping opportunities on ICTV. Twelve still frames of video turn a model completely around, for example, so you can see all sides of an outfit in an interactive catalog.

The system also anticipates movies or products that might interest you. If you've requested movies with particular actors previously, your TV mailbox alerts you when upcoming films include these performers. ICTV could also carry classified advertising directed at you—instead of having to search for it. "It shifts the whole information paradigm," says Serlin. "Once you've established you're looking for a yellow Ford station wagon or an apartment in a certain area of town, you become a qualified prospect." Vendors would be notified what you are shopping for and could contact you.

Hoarty acknowledges the interactive TV "concept pieces" demonstrated at the warehouse are being generated by an Apple Macintosh computer. In fact, when the system is asked for titles of more upcoming movies starring Michael Douglas, the demo crashes and a system-error message appears on the TV screen. Nevertheless, Hoarty promises, the interactive channels will be real at a pilot project ICTV expects to be running on a Bay Area cable system next year.

A two-way cable system that lets viewers express some preferences is already running in Queens, N.Y. Time-Warner Cable's Quantum system provides 150 channels using a hybrid design of individual glass fibers for transmission to each neighborhood and coaxial cable for the last mile to homes.

Much of this capacity is being used for multiple feeds on pay-movie chan-



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Scientists and researchers agree. A good night's sleep is vital for health and well being. The problem is...most of us are being cheated out of a good night's sleep.

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"It has allowed me to sleep undisturbed for the first time in years."

The SOOTHER COMPANION™ reproduces the calming sound of the ocean surf to lull you to sleep. It is more than just a static "white noise maker". You actually hear the rise and fall of the surf. And with a touch you can add a mix of seaside sound. Foghorns, a buoy bell, seabirds' calls, etc. It comes complete with AC adapter and plugs into any wall outlet. The seaside and alarm sounds use AC power. The back-up batteries (2 AA batteries) wake you with an electronic tone.

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gain when you think how valuable your sleep really is. Small, compact, using state of the art microchip technology to reproduce these soothing sounds. Besides on/off and separate volume controls for surf and seaside sounds, you can even set the SOOTHER COMPANION™ to come on in 60 minutes, or to play for 60 minutes. The alarm will wake you with the lovely sounds of a rooster, or sea loons or Big Ben. Digital clock with standard or military time. Connections for Audio In, Audio Out, or Companion speakers.

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Take this simple test...

1. Are you getting the correct amount of sleep?

The right amount of sleep is important. But more important is the quality of sleep you get. Consider how you feel when you wake up. If you feel refreshed, ready for an active day, then you've probably had enough sleep and the quality has been satisfactory. If not, you should consider what you can do for better sleep.

2. What is the average amount of needed sleep?

The natural range of needed sleep for adults is five to ten hours. Most folks need about seven and one-half hours. But if you're disturbed several times throughout the night by urban noises...you're being cheated out of precious sleep time. It's no wonder so many people awaken feeling groggy, achy and irritable. People who own the SOOTHER COMPANION™ report they fall asleep faster, awaken more refreshed, and actually need less sleep.

3. Can a person sleep too much?

Some might say yes. But it could be you are not getting the right kind of sleep. Your sleep may not be deep enough. You may be disturbed several times a night and not even know it. That's why the SOOTHER COMPANION™ is so valuable.

4. Is sleep an active process?

Normal sleep patterns show almost constant change and activity. Certain research has shown that during some stages of sleep the brain emits electrical impulses faster and more intensely than during waking time. We all go through four stages of sleep within the sleep cycle. The two most important stages of sleep are Stage 1 or REM (rapid eye movement) sleep when your dreams take place, and Stage 4, or Delta sleep, the deepest stage, when your physical and mental energies are recharged. Each time you are disturbed during delta or REM sleep you lose their beneficial effects. That's why it's important that the changes in the sleep cycle happen from within the body and not from outside noises.

5. Just how important is sleep?

Very important to maintain good health. Lack of sleep or for periods as short as 60 hours can produce dangerous psychological and physical symptoms. Even a missed night of sleep has a definite effect in terms of dulled perception. Reduced reaction time. And memory impaired judgement. Not to mention increased feelings of depression. Be sure to get the right amount of quality sleep you need. Consider the SOOTHER COMPANION™ at no-risk or obligation.

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Interactive TV

(Continued from page 124)

nels. You can begin watching an 8 o'clock movie at 8:20 or 8:40, for example. Pay-per-view movie and event offerings are ordered off the screen with a remote control. Signals travel back along cables to Quantum's computers. Basic cable subscribers pay \$23.95 a month (not including pay cable channels). Prices for pay-per-view films range from \$1.95 to \$4.95 each. Although Quantum can be upgraded for more sophisticated two-way interaction, Time-Warner is vague about such services.

Computer service on cable

In this country, the most popular interactive videotext service, Prodigy, is delivered via phone lines, modems, and personal computers. But the shop-at-home and information service was designed to be platform-independent. A spokesman for the White Plains, N.Y., company, owned by IBM and Sears, says Prodigy may be tested on a cable-TV system.

Meanwhile, IBM is talking to Time-Warner about broadening the ability of cable systems to deliver two-way services by installing digital switchers and routers the computer company has developed. IBM was expected to begin testing switched digital video on a cable TV system in Toronto this fall.

The Game Show Channel is expected to start up next year in a partnership between Sony Pictures Entertainment and United Video Corp. Sony owns some 10,000 episodes of "Jeopardy" and "Wheel of Fortune" suitable for interactive TV.

Roy Bliss, president of United Video in Tulsa, Okla., which is known for its Prevue Guide channel, says the "interactive" part of The Game Channel will initially be limited to viewers picking up their phones and dialing 800 or 900 numbers. He figures that real on-screen interactivity for most of the country not requiring telephone dialing is at least five years away.

Another 900-number dial-up cable service, The Box (formerly the Jukebox Network), now lets viewers call in their requests for music videos.

Interactive services that are likely to spread more rapidly are near video-on-demand and interactive program guides. Earlier this year, InSight Telecast in Fremont, Calif., ["Smart TV," Nov. '90] signed a five-year agreement with Zenith to build Insight's decoding chips into Zenith cable boxes, VCRs, and color TVs. Weekly on-screen listings will be carried to the home on an unused portion of PBS broadcast signals. You'll be able to control tuning or set your VCR from the listings. But

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Interactive TV

(Continued from page 126)

unlike VCR Plus, a device that's already on the market, you won't have to punch in a number code now listed in many newspapers and *TV Guide*.

Company president Michael Faber estimates that the initial fee for the In-Sight guide will be \$38 per year—less than a subscription to *TV Guide*. One of In-Sight's owners is Viacom, which plans to incorporate the In-Sight program guide in a two-way cable system test next year in Castro Valley, Calif. Industry insiders say the system is likely to go far beyond the capabilities of the Time-Warner coaxial-cable/fiber system in Queens.

Video dial tone

TV Guide has formed a joint venture with Liberty Media in Denver to produce on-screen listings too. In addition, United Video will sell a small box called TV Trakker, connected between the cable and your converter box. Instead of waiting for program listings to scroll by, you will be able to page up and down through up to eight hours of listings, including movie descriptions, prime-time grids, and color-coded categories stored in 128 kilobytes of memory. Bliss says the device and a five-button remote, which can be tucked away if you have a universal remote, will cost \$40; an annual subscription will go for \$49. The service is being rolled out initially in Tulsa and Omaha.

Cable, computer, and entertainment companies aren't the only ones hoping to sell you some form of interactive TV. The phone companies also want a piece of the action. The FCC in July ruled that Baby Bell regional phone companies may transmit television programming to homes over phone lines. Supporters of the change say competition from the phone companies might help reduce your cable TV bill and step up construction of fiber-optic cables needed to transmit TV images. The idea is for the phone companies to provide a video dial tone ("Fiber Optics Head for Home," March '91). When hooked to a TV set, the signal would allow you to view any program you wanted on demand and be billed accordingly.

Consultant Gary Arlen of Arlen Communications in Bethesda, Md., counts 36 interactive-TV projects under way as of last summer. Few are yet available to consumers, and most will require you to purchase extra equipment, order a subscription and/or pay for each transaction. With the coming assault on America's lethargic viewing habits, true couch potatoes could be severely tested. You'd better catch your 40 winks now.

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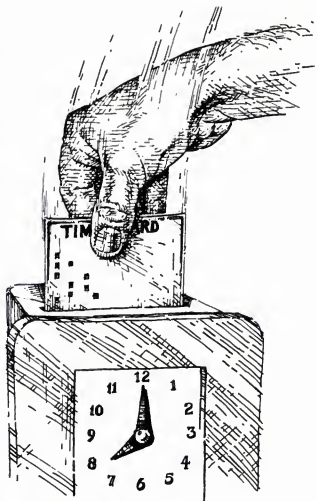
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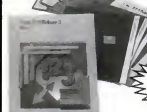
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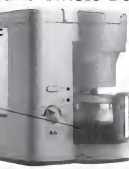
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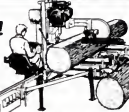
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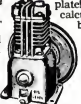


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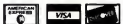


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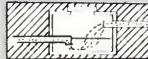
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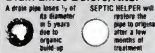
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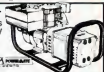
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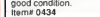
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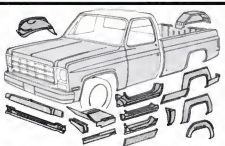
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Looking Back...

Sampling a century of POPULAR SCIENCE

25
YEARS AGO

NOVEMBER 1967

With service and interiors like airliners, new trains will slash time schedules at intermediate distances to woo you from the crowded roads and the airways. You've never experienced this kind of rail transit. These trains can whoosh from a dead stop to 125 mph in less than two minutes. Vibration and sway are low. The coaches are full of luxuries: soft carpeting, phone service, carry-on luggage racks, personal seat lighting, curtained windows of tinted glass, hostesses, and taped music.

Average speed? That depends. While the railroads involved will con-

fine themselves to 100 to 110 mph in spurts, the *Pennsylvania* averages close to 80 mph on the 226 miles between New York and Washington—20 mph faster than standard trains. The *New Haven* plans to average 72 mph between Boston and New York; and *Canadian National*, 85 between Montreal and Toronto.

That's just for now. The *Pennsylvania's* ultimate goal is a 115 mph average, New York to Washington. Within two years a constant speed of 125 mph may be common; the designers are talking confidently of 150 mph by 1970. Limiting factors now are roadbed and curves. The trains themselves can do 160 without panting.



This new high-speed train will travel at speeds of more than 100 mph.

50
YEARS AGO

NOVEMBER 1942

After this war is won, Americans should be able to travel faster and live better than ever before. New discover-

ies are emerging from greatly increased wartime research by almost every branch of industry. But, no field has more dramatic possibilities than that of transportation, and the greatest developments will come in the air.

The cargo plane will be specially designed for its work: It will have a very high-lift factor, will have both nose and side hatches for loading cargo, and will have a relatively low landing speed to get into small airfields.

Giant passenger planes are sure to come along. Some designs for a super-airliner complete with sun lounge,

promenade deck, eight engines, and so on had even been publicized before the war.

The family plane trade must depend for its real success on the development of a low-cost, completely safe airplane and the building of literally thousands of new airfields. Designs for the planes are in hand, most of them using tricycle or four-wheel landing gear and having collapsible wings.

New super highways are being planned with landing facilities for private flyers. Flight strips will parallel the road where they follow the direction of the prevailing wind. Gas stations, with hangar space, will take care of the fuel needs of small planes as well as automobiles.



This aerial family "car" has retractable tricycle landing gear and high-lift flaps for steep takeoffs and landings on small fields.

100
YEARS AGO

NOVEMBER 1892

What we call a lead pencil is really a graphite pencil. During the reign of Queen Elizabeth, the graphite beds of Borrowdale in Cumberland, England, were discovered, and with them the material which was destined to stimulate the rapid development of the pencil industry.

The pencils made in England then were quite different from the present products. Graphite was sawed into small sticks and enclosed in wood. The Cumberland pencil was regarded as

unsurpassed—distinguished by an extraordinary softness and delicacy in the drawing—and was extremely costly. Since only the best and purest material was being used, this supply was exhausted in a relatively short time.

Manufacturers began to pulverize the waste and to mix it with other materials, to press the mass into hard cakes, and saw it up in the old way. But these pencils were not comparable with the old Cumberland brand.

New graphite beds were then discovered in Bohemia, the product of which was still far inferior to that of

Borrowdale. After some time, manufacturers learned to purify the Bohemian graphite by a careful chemical process; toward the end of the last century both a French and German maker came upon the idea of mixing purified graphite, finely ground, with moistened clay.

The invention is useful in three ways: It made possible, through variations in the proportion of the ingredients, making pencils with different degrees of hardness; it simplified the manufacturing process; and it made pencils so cheap that they became within the reach of all.

PICKUP

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